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# TRANSACTIONS

OF THE

# GEOLOGICAL SOCIETY OF GLASGOW.

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# TRANSACTIONS

OF THE

# GEOLOGICAL SOCIETY

# OF GLASGOW.

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# TRANSACTIONS

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# GEOLOGICAL SOCIETY OF GLASGOW.

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## I.—On the Post-tertiary Beds of Garvel Park, Greenock.

By David Robertson, F.L.S., F.G.S.

WITH TWO SECTIONS. [PLATE I.]

[Read 14th April, 1881.]

Many of the members will remember the interest that was taken in the fossils which were exposed in the excavation of the Dry Dock of Garvel Park, Greenock, eleven years ago, and the lively discussions at the meetings of the Society from time to time, regarding the various sections as they were laid open. The recent commencement of the excavation for the Wet Dock at the same place gave hopes of a renewal of the same interest, which have not been disappointed. Although the much greater extent of cutting has brought clearly into view the normal sequence of the beds, leaving little or nothing for difference of opinion on that point, yet the interest has been well sustained by the unusual variety and distribution of the fossil remains. During the excavation of the Dry Dock our workers were mostly, if not all, from Glasgow. This time there has been a strong accession from Greenock, amongst them Messrs. J. and T. Steel, and prominently Mr. Thomas Scott, whose untiring industry has been rewarded with many of the fortunate finds of the place. In preparing the lists of fossils my thanks are due for assistance in the identification of doubtful and critical species; to Dr. Gwyn Jeffreys, for Mollusca; to Mr. H. B. Brady, for Foraminifera; to the Rev. A. M. Norman, for Polyzoa; to the Rev. R. T. Ferguson, for Mosses; to Professor Dickie, for Algæ; and to Professor Bayley Balfour for Vascular Plants; the lists through their help having received a value, as stated on other occasions, that they could not otherwise possess.



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*Boulder-clay.*—It is beyond the scope of this paper to enter into the many theories adduced to explain the mode of deposition of the Boulder-clay, and I shall therefore confine my remarks, with few exceptions, to that met with in the section at Garvel Park. It is similar to what we find all over the West of Scotland, which has been so often described as a stiff unstratified clay, more or less crowded with stones varying in size from small gravel up to blocks of several tons weight. There may be generally about 50 per cent. of these stones water-worn, and some kinds more frequently showing striation than others, owing, apparently, to the composition and greater or less compactness of the stone. Perhaps the best preserved striations are found on limestone and hard shale. The following is a list of the contents of a small parcel of Boulder-clay from the south end of the dock, 14 feet under the surface, excluding stones over $1\frac{1}{2}$ ounces in weight:—

| | |
|---|---|
| Fine Mud, ... ... ... ... ... | 68 per cent. |
| Sand, all angular, chiefly quartz, ... .. | 15 ,, |
| Small gravel, $\frac{1}{4}$ quartz, $\frac{3}{4}$ dark coloured, ... | 6 ,, |
| Larger gravel, $\frac{1}{7}$ quartz, $\frac{6}{7}$ schists, ... ... | 11 ,, |

In a collection of larger carried stones as the size increases so does the proportion of dark schistose rocks, the smaller portions of which have apparently been ground and triturated into an impalpable powder forming the great proportion of fine mud which I have noted, while the quartz chiefly remains as fine sand. It might at first be supposed that the sandstone of the district has supplied the greater portion of this quartz sand; but seeing that few of the sandstone boulders, large or small, found in the clay, are polished, but are mostly angular, it is more likely that the sand has been derived from the grinding down of the quartz contained in the older rocks.

Although the Boulder-clay of Scotland is not stratified in the true sense of the term, yet it is sometimes found traversed horizontally with a band or two of different colours. Good examples of this were seen in the clay overlying the sandstone quarry at Possil; in the railway cutting at Fallside, about six miles east of Glasgow; and in a section exposed on the north side of Dumbarton Road, at the iron bridge over the Kelvin. The main clay at all three places was dark grey. At Possil quarry and Kelvin Bridge the bands were reddish-brown, two bands in each from 15 to 20 inches in thickness. At Fallside there was only one band, of a

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whitish colour, sharply defined, and contrasting strongly with the dark-grey clay in which it was intercalated. These bands appear to be local, possibly owing their existence to the unburdening of icebergs. It is a usual occurrence to find from four to seven feet of the upper clay of a browner colour than that beneath, which may be accounted for by the frosts of many years having penetrated to that depth, and, having loosened the clay so as to admit, on every renewal of the thaw, of additional water, whose oxygen, combining with whatever traces of iron might be present in the clay, would give its present brown or rusty colour. In regard to a distinction being drawn between an upper and a lower Boulder-clay, such would ill agree with the theory of their being laid down under land ice. In some cases no doubt Boulder-clay may present a more or less stratified appearance near the surface, from a re-wash and re-arrangement of its own materials.

The occurrence of sand deep in the Boulder-clay is not infrequent, sometimes in nests or pockets, and sometimes in more extensive layers, generally thinning out on both sides. If, as is now generally believed, our true Boulder-clay was laid down in water, these pockets and lenticular masses of sand would seem to indicate some particular disturbance or interruption of the currents. This we may conceive would take place on such an occurrence as the stranding of an iceberg, when the impeded water would rush round the sides of the obstruction and wash out the soft mud, leaving the heavier sand behind, or carrying it to a greater or less distance, according to the force of the newly-formed currents. Icebergs, as is well known, are often of very irregular curves, which might form eddies that would scoop out holes or pockets, leaving the heavier sand that had been freed from the mud. In some such way we may suppose these beds and nests of sand found intercalated in the Boulder-clay were produced. There was lately to be seen a good example of one of these nests or pockets in the Boulder-clay on the north side of the dock, a little to the west of where the shelly clay cropped out.

The Boulder-clay, with few exceptions, is apparently destitute of shells, only a water-worn fragment or two having been found in the true Boulder-clay of the West of Scotland.* In the so-called Boulder-clay of Caithness, on our eastern coast, shells are

* A valve or fragment of *Astarte sulcata* found in Ayrshire, deep down in Boulder-clay, was shown to me by Mr. Robert Craig, *cor. mem.*, Beith.

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numerous, but the animals evidently have not lived and died where the shells are found, they being all water-worn, mostly fragmentary, and promiscuously scattered through the clay from top to bottom. This clay must, therefore, have been laid down under very different circumstances from what is understood as true Boulder-clay, as restricted by Professor A. Geikie to the pell-mell agglomeration of clay and boulders so well known in Scotland.*

Among the many aspects of the Boulder-clay which are difficult to explain, I may mention three—(1) Whether the Boulder-clay is purely a marine deposit, that is, that the mud carried down from under the glaciers, as is seen in all recent cases, has been carried from under them into the sea, and the stones chiefly supplied from the bergs. If such has been the case, we must admit that the grindings of the rocks by the glacier as it crept downwards from the top to the foot of the incline, must have been mixed together in the stream as they passed along. It is, therefore, reasonable to suppose that these raspings from the different coloured rocks thus mixed would give this mud which forms the clay a homogeneous colour. According to this it is difficult to explain how the Boulder-clay takes, as has been shown,† the colour of the rock over which it lies, that is red clay over red rocks, and dark clay over dark-coloured rocks, nor is the real difficulty removed by supposing an overlapping to some extent of the one division over the other. (2) It has been advanced that glaciers press heavily on the underlying clay and squeeze it into every recess, and move it from one place to another. Yet it is remarkable that this mass of sub-glacial clay has never been detected coming up through the many rents and fissures so common over the recent glaciers, which would be an easy exit for the pent-up clay from the enormous pressure of the overlying ice-field. (3) If the clay has been laid down in water it is difficult to conceive why we do not find the fossil remains of marine animals in the great depths of Boulder-clay in the West of Scotland, as it is well known that animal life has been always more or less abundant in all our seas.

*Shell-bearing Laminated clay.*—This clay, exposed in the excavation for the new wet dock at Garvel Park, Greenock, I need

* A. Geikie, Phenomena of the Glacial Drift of Scotland, *Trans. Geol. Soc. Glas.*, vol. i., part 2, page 35.

† *Trans. Geol. Soc. of Glasgow*, vol. i., part 2, p. 37.

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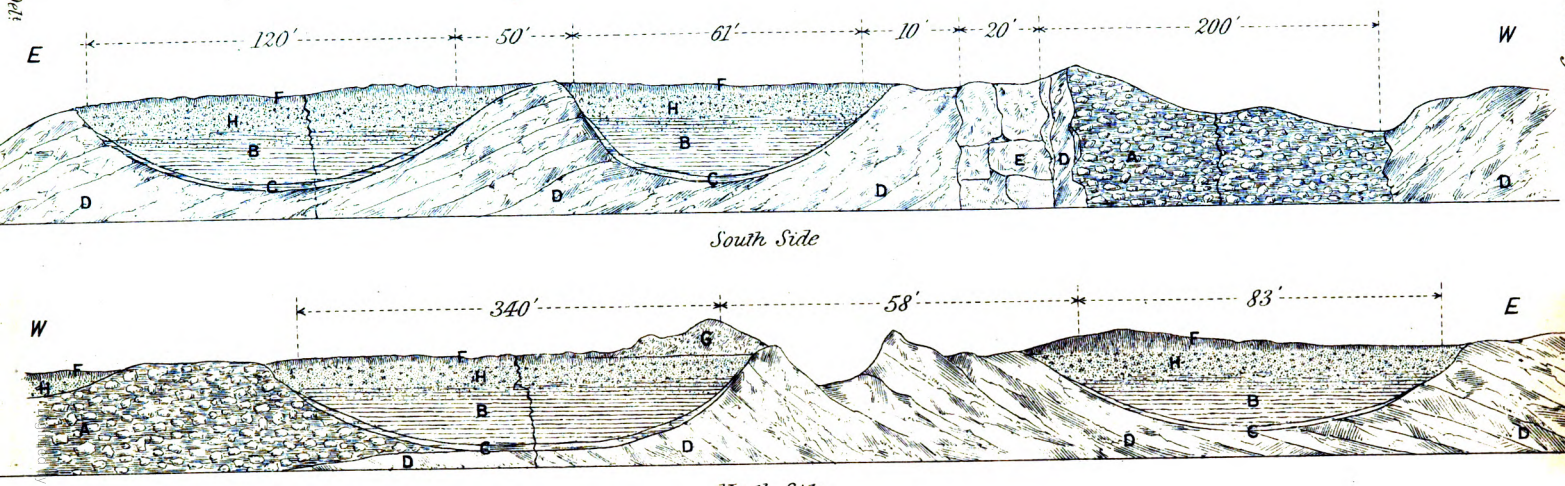


## SECTIONS OF POST-TERTIARY CLAY BEDS AT GARVEL PARK, GREENOCK

A *Boulder clay*
B *Laminated fossiliferous clay*
C *Light coloured clay, slightly fossiliferous*
D *Red sandstone & conglomerate*
E *Felstone porphyry*
F *Soil*
G *Rubbish*
H *Fossiliferous muddy sand*



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scarcely say, is one of those patches of the same deposit found so plentifully at various points all over Scotland, particularly in the valley of the Clyde. These clays abound chiefly on the lower grounds, and in sheltered hollows where they have been least exposed to denuding agencies. In Scotland they have a considerable vertical range, being met with in the Island of Lewis at between 300 and 400 feet above sea-level,* and at Chapel-hall, near Airdrie, at an elevation of 530 feet. On the other hand, at Dryley's brickwork, near Montrose, which is only a few feet above high-water mark, the fossiliferous laminated clay is worked to the depth of 50 feet, and the foreman stated that the same deposit had been bored to the depth of 100 feet. In the Kyles of Bute, at Largs, Greenock, and other parts of the Frith of Clyde, the shelly clay extends out on the shores beneath low water mark.

It may be mentioned that the hard and gravelly muddy banks, so commonly met with in moderate depths of water all round our shores, are a feature which we do not find appearing among our laminated clays. This may be due to a covering of ice which would prevent the storm swell from reaching the bottom to wash away the finer material, and heap up the gravelly and shelly banks. This shelter would continue to some extent even were the ice broken up, as may be seen from the familiar fact that, in some places where milk or water is carried in pails, a piece of wood floating on the surface keeps down in a great measure the agitation of the fluid.

The clay in the new or wet dock crosses the section in two distinct hollows or troughs. Of these the more westerly crops out on the northern side of the dock against the Boulder-clay (in a line nearly due north of Macdougall Street), and extends eastwards for about 340 feet, where it is divided from the eastern trough by a ridge of conglomerate 58 feet in breadth. From this the eastern hollow filled with laminated clay extends about 80 feet, but on the southern side of the dock it attains a breadth of 120 feet, bounded on both sides by sandstone. On the same side the western hollow narrows into a deep gorge 61 feet wide, bounded by sandstone on the east, and cut off by a dyke of felstone porphyry about 20 feet in breadth, which runs N. 30 E., and dips towards the Clyde,

* *Trans. Geol. Soc. Glas.*, vol. vi., pt. 2, p. 248.

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which is about 200 yards distant. This dyke is not seen at low water, nor is it known in the channel of the Clyde. It is flanked on the west by Boulder-clay extending about 200 feet, when the sandstone again comes up. Taking the western trough at its deepest part, on the northern side of the excavation, as seen in May, 1880, we have the following section in descending order.

(1st) About 1 feet of mould.

(2nd) 2 feet of sand.

(3rd) 4 feet of dark coloured sandy mud, becoming less sandy as it descends, till it merges into

(4th) A tenacious grey clay occupying about 4 feet, overlying

(5th) A layer of whitish clay, which is generally from 4 to 6 inches thick, but in some places deepens from inequalities of the under stratum into a thickness of from 12 to 15 inches. Under this whitish stratum we find at some points, as in the present instance,

(6th) Certain thin layers of stratified sand, resting on Boulder-clay, or

(7th) Sandstone rock.

As the excavation proceeds the arrangement of the bed changes to some extent either as regards the character of the laminæ or their relative thickness. At the point where this section is taken the sandy clay under the white layer is extremely red, and scarcely more adhesive than to stick together when dry, and as it descends it becomes a pure sand, thickly intermixed with small gravel, resting on the rock. About 40 per cent. of this gravel belongs to the metamorphic schists of Argyllshire, and, with few exceptions, is rounded and polished. Only one or two pieces were noticed to be indistinctly striated. The remaining portion of the gravel is chiefly derived from the sandstone of the locality, and is for the most part angular. In other parts of the cutting this under layer in the dock becomes a pure red clay. Generally throughout the laminated clays in the dock the stones are few and mostly small, and similar in character to those found in the Boulder-clay, with the exception of two nodules of flint, which, so far as I know, has not yet been met with in our true Scottish Boulder-clays. Both of these pieces were found near the bottom of the section of the tenacious clay. Although the stones in this section of laminated clay are generally small, one may be seen here and there exceeding a foot or two in

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diameter and generally having *Balani* attached, these in most cases being limited to a certain zone round the boulder, indicating the depth it has been imbedded in the mud during the time the *Balani* were growing upon it. Whether that was before or after its lodgement in the laminated clay has not yet been clearly shown.

Since the above was written an extension of the cutting to the west on the north side of the dock has been made, and this has revealed to us another light-coloured sandy shell-bed, overlaid by a bed of pure sand, from one to two feet thick, with the usual covering of mould. This is obviously a continuation of the bed seen rising from the dry dock up to near the surface at the north side of Garvel Park House, and now well seen at both north and south sides of that building, in an excavation which has been made to underbuild and bring the house to the level of the docks [Feb. 1881.] The fossils in some particulars differ from those of the wet dock. The bed is probably the lip of the basin of the shelly clay of the dry dock cut off from the shell-bed on the east by the Boulder-clay whereon the eastern shell-bed cropped out. This newly opened shell-bed appears to have much of a littoral character. At some points *Littorina littorea* is in great abundance, together with *L. rudis*, which is moderately common. In a small parcel of clay taken from the same bed at the north-west corner of Garvel Park House the foraminifer *Polystomella crispa* was in great abundance, and in fine condition and beautifully white, and at this point with scarcely any other microzoa.

*The Fossils and their arrangement.*—Except the plant remains, the fossils obtained in this excavation are, generally speaking, similar to those met with in the Post-tertiary clays all over the West of Scotland. These, however, as we have frequently had occasion to notice, differ greatly in their groupings in different localities, and often within very short distances. We have a striking instance of this in the fact that the fossils met with in the excavation of the dry dock, and, as has been stated, in an obvious extension of the same clay-bed, and distant only about 100 yards, differed greatly in many particulars from those met with in the present excavations.

There, Polyzoa, *Balani*, *Tectura virginea*, *Puncturella Noachina*, and *Trochus Grœnlandicus*, were much more abundant than they are in the clay now exposed. On the other hand, in the present cutting *Saxicava* (*Panopœa*) *Norvegica* and clusters of

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scales of *Psolus phantapus* are common, while not a trace of these was seen in the excavation of the dry dock. Again, *Lacuna divaricata* and *Utriculus obtusus* are larger and greatly more abundant in this than in the former cutting, and many other species differ to some extent in their proportions. This, we repeat, is frequently the case in the same excavation, and sometimes within a few yards in the same layer, when any change of material occurs, or, as sometimes may be seen, in the talus on the lee side of a boulder sheltering a debris conducive to the wants of a particular species. *Odostomia unidentata*, *Mölleria costalata*, and *Rotalia Becarrii* are examples contained in such restricted places in the present cutting.

Although it is found that the fossils obtained in the present cutting are not so abundant and varied at any one point as they were in the adjoining dry dock, yet the great extent of shelly clay cut into at the wet dock, and the great length of time the work has been going on, and new ground being broken from time to time, have afforded rare opportunities of bringing to light a long list of organic remains, which has in most cases resulted in an increase of genera and species over those of the dry dock. Subjoined are comparative lists of the species and varieties obtained in the clays of the two excavations.

| | OLD DRY DOCK. | NEW WET DOCK. |
|---|---|---|
| Algæ, | 3 | 7 |
| Musci, | 0 | 54 |
| Seeds of Vascular Plants, | 0 | 16 |
| Spongidæ, | 1 | 1 |
| Foraminifera, | 26 | 84 |
| Hydroida, | 0 | 3 |
| Echinodermata, | 7 | 7 |
| Annelida, | 3 | 6 |
| Ostracoda, | 35 | 45 |
| Decapoda, | 1 | 4 |
| Cirripedia, | 5 | 5 |
| Insecta, | 0 | 2 |
| Polyzoa, | 28 | 16 |
| Mollusca, | 65 | 115 |
| Vertebrata, | | Fish and bird bones. |

The land plants were not noticed in the clays of the dry dock. The great preponderance of polyzoa obtained in the same deposit did not arise from any special search made at that time for that

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class of animals, but from the great abundance that prevailed in a very small basin. Their profusion may be accounted for in some measure by the greater number of stones, large and small, met with in the laminated clay of the dry dock, and which afforded the means of attachment favourable for their growth.

A very thin stratum overlying the white band of clay at the base of the shelly deposit consisted almost entirely of *Idmonea Atlantica*, and most of the examples of this species met with in the present cutting held nearly the same position. The great excess of foraminifera obtained in the wet dock over those of the dry dock may be principally owing, as already stated, to the great diversity of deposit and to the prolonged opportunities for search. Apart from this abundance, which in the class of organisms exceeds all the species that have hitherto been recorded from the Post-tertiary clays over all Scotland, there are a few species which have only been found before at great depths in the deep-sea dredgings of H.M.S. "Challenger," and a short notice of which I brought before the Society at a former meeting. Amongst them was *Sorosphœra confusa*, the remarks regarding which may be repeated here, as they agree well with the habits of the others. Mr. H. B. Brady says, "The distribution of *Sorosphœra confusa* appears to be somewhat local, but in areas wide apart. It occurs amongst the 'Challenger' gatherings at one station in the North Atlantic (off the Azores, 900 fathoms), at one in the South Atlantic (off Buenos Ayres, 1900 fathoms), and at two points near together in the North Pacific, (2050 and 2900 fathoms respectively), and in one of the 'Porcupine' soundings in the North Atlantic." When we look to the great difference of depth between those found in the Atlantic and those at Garvel Park, which could only be of very moderate depth—a circumstance proved by their association with shallow-water shells and sea-weed—it is difficult to see how these lowly forms of abyssal habitat have been located in the clays of the valley of the Clyde; and we may readily suppose that they are stragglers or waifs brought hither by accidental circumstances. On the other hand, when we consider that the general cold which obtains at great depths would agree well with the presumable cold existing in our shallow seas at that time, our surprise will be less when we take into account the vast bathymetrical range of many of these lowly forms. We may take, for example, the common *Globigerina*, which, though found at the greatest depths in-

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habited by any living animal, is one of the fossils of Garvel Park clay, as well as of other clays in the West of Scotland, and recent in our shallow seas. The unusual number of extra-European species making their appearance in this contracted spot gives it a resemblance to some of those anomalous places exemplified in the Dogger Bank with its peculiar molluscan fauna. The plants, and the great number of mollusca which must have fed on such plants as are found in the shell-bearing clay of Garvel Park, furnish ample proof that the upper strata in particular have been comparatively shallow-water deposits. It may be reasonably inferred that the character and sequence of the beds agree well with an elevation of the land during their deposition, as the usual deeper pure mud beds are at the bottom and become the more sandy as they ascend, while the mollusca merge more into shallow-water species as they approach the surface, including *Lacuna divaricata*, *Rissoa interrupta*, and *R. striata*, with a small introduction of shells belonging more to the old Raised Beach or to recent seas than to those of the glacial fauna, such as *Mactra elliptica*, *Lucina borealis*, and *Cerithium reticulatum*, but still associated with arctic shells.

Near the north-east end of the dock an old Raised Beach comes on immediately over the dark blue clay, the line between the two being sharply defined, and there being no merging of the one into the other. The blue clay is sparsely studded with the usual assemblage of Post-tertiary shells, such as *Pecten Islandicus*, *Tellina calcaria*, etc., while the overlying old Raised Beach is densely crowded with shells of our present shores, but although it was carefully searched for arctic shells not a trace of them could be detected, a circumstance which would distinguish it beyond doubt from the upper Post-tertiary sandy beds previously referred to.

Throughout the clay the shells seem to have a tendency to be disposed in layers, which is more noticeable immediately over the white stratum referred to at the base of the section, but, in all cases, such shells are mostly large single valves of dead shells—*i.e.*, shells that have lain dead for a time on the sea-bottom before being covered up, as is shown by the parasites attached to the inner surface of the valves. This was the case, in an exceedingly marked degree, in a section laid open during the excavation of the older docks in Greenock Harbour in the year 1865. There, a thick layer of shells, chiefly *Pecten Islandicus*, and *Cyprina Islandica*,

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was found overlying the thin white stratum of clay resting on the Boulder-clay. It is difficult to understand the apparently sudden appearance and accumulation of these shells at so early a period of the deposition of the clay, and their apparently sudden disappearance after this layer was deposited. There are, however, other bands of shells occasionally met with in higher zones of our Post-tertiary clays, probably pointing to the well-known fact that colonies of molluscs congregate on different parts of the sea-bottom for years, and then disappear. This may take place from various causes, such as their abundance attracting an overpowering number of their enemies, or their own increase outstripping their means of subsistence, or a change of conditions of the sea-bottom. The small shells in the upper sands of the section are frequently found crowded together in small patches, such as are found in the recent state, feeding abundantly on the fronds of seaweeds, and they are, naturally enough, therefore, found clustered in the mud amongst the remains of the plants whereon, in life, they did most abound.

*State of preservation of the calcareous fossils.*—The fossils here are in fair condition, except those near the surface. The different states of preservation seem to depend as much, if not more, on the composition and character of the matrix in which they are imbedded than on the texture or mineral constituents of the shells themselves. In a valuable paper by H. B. Sorby,* on the mineral structure of shells, he shows that when they are chiefly or wholly composed of aragonite, which gives them a higher specific gravity, and renders them harder than when they are chiefly or wholly composed of calcite, they appear to be more liable to decomposition. He gives examples of the decay of shells taken from a raised beach at Hope's Nose, near Torquay, where he found the inner layer of aragonite in *Mytilus edulis* had been completely removed, whereas the outer layer of calcite in the same shell was well preserved. It will be observed that these shells were taken from a Raised Beach, which, doubtless, had the same general characters as other Raised Beaches, being composed of loose gravelly materials lying at or near the surface, and exposed to frosts and rains, which drained through the pervious soil or gravel; a certain erosive action taking place on the exposed aragonite of the inner surface of the valves of the shells, while the outer surface was protected by the epidermis. But these conditions would give little or no indication of what

* Anniversary Address, *Quart. Journ. Geol. Soc.*, May, 1879.

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would take place when the shells were embedded in compact, stiff clay, where the action of these exceptional agencies would be excluded.

We find, when the fossils are near the surface in the Post-tertiary clays, they are generally more or less brittle, and the colour to a greater or less extent deteriorated. *Pecten Islandicus*, for example (a calcite shell), when very near to the surface, or exposed to the weather, becomes of a dirty white, while, when less exposed, or in a close sandy matrix, it retains its natural red colour. Those enclosed in the grey tenacious clay are, in most cases, well preserved, and take on much of the dark colour of the clay, as seen in the specimens on the table. It will also be seen from many of the specimens that the nacreous aragonite layers of the shells are in a fair state of preservation, while the more, or purely, calcareous layers are eroded away. This is well exemplified in many of the Trochidæ, particularly *Trochus cinerarius*, *T. tumidus*, and *T. Grœnlandicus*. In these cases the exposed inner pearly layers are generally well preserved, while great patches of the outer calcareous or calcite layers are eroded down till arrested by the intercalation of pearly layers which appear smooth and lustrous. It is further seen that the inner pearly layers of various species of *Nucula* appear to retain all their pristine beauty, while other shells in the same deposit have suffered much from erosion, and it is no unusual thing to find pearls in a fine state of preservation in the Post-tertiary clays.

There is every reason to believe that, in many parts of the Post-tertiary beds, the shells have been decomposed by solvents irregularly present in different parts of the clay, as we often see them reduced to pulp, or the casts only left without a vestige of the mineral structure, while at no great distance, in the same layer, others may be found quite entire. Indications of this are most frequently seen in the black-coloured patches in stiff clay, which have been probably darkened by vegetable remains. These differently coloured patches may help to explain why shells of the same species are occasionally met with in the same layers at short distances apart in different states of preservation.

Another fact may be taken into consideration, that the chitonous or horny epidermis, which is often found in the clays in a fine state of preservation, must in many cases be a great protection to the outer shell. The power of these chitonous structures to resist

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weather influences is well exemplified in a paper by Mr. James Bennie,* now of Edinburgh, who found a great number of the epidermal coverings of *Unio margaritifera* in gravel or river drift, during the excavation of the dock at Windmillcroft, Glasgow, "most of them lying in natural position, with the umbonal portion undermost, proving that they lived and died in the gravel, while not a vestige of the shell remained, in any instance, attached to the epidermis, having been dissolved by the action of rain-water percolating through the soil and acting on the inside of the valves which were ill-protected by the loose sand and gravel in which they lay." It has been supposed that the shells found in sand are in general better preserved than those in the clay. This was well marked in the case of the shells found in the sandy deposits of Dalmuir, Oldmains, and Garnock, and was perhaps more noticeable as regards *Pecten Islandicus* than any other species. Such a conclusion would, however, in most cases be erroneous, for often the fresh appearance of the shells is caused rather by an eroding process keeping down incrusting or staining matter than by actual preservation of their structure, which, when examined, is often found to have become loose and scaly in texture. In some sandy deposits, as at Kilchattan Tile-works, the shells are in a fair state of preservation. Probably this may, in a great measure, be accounted for by the mineral ingredients (iron and lime) contained in the sand, which have a tendency to bind or cement it together, and the same result may also be partly due to the sand lying in an impervious hollow of clay. In cases, however, where the water percolates freely through the sand the carbonic acid held in solution must have a destructive tendency on all fossils containing calcareous matter, and this is probably the chief reason why we so seldom find fossils in the numerous sandbanks over the country. Peat, which is known to contain a sensible amount of free acid, is also destructive to molluscan remains.

With regard to the different susceptibilities to decay of some species of invertebrate fauna we may take as an example the foraminifera, which, in some cases in the same piece of clay where the strong shells of mollusca have suffered greatly from erosion, show the most delicate lines of ornamentation in a perfect state of preservation. This is more observable in the *Lagenæ*, and other transparent species, than in those of more opaque texture. The

* *Trans. Geol. Soc. Glas.*, vol. ii., p. 109.

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same immunity from injury or decay appears to hold good to a great extent with the Post-tertiary ostracoda.

In looking over my collection of Post-tertiary shells from many different localities I find that the various members of the genus *Astarte* are least impaired by their long lodgement in the clays. Perhaps *Pecten Islandicus* may be next strongest in resisting time, which was well illustrated in a sample of clay I had from Mr. Stanford, of the Chemical Works at Dalmuir, taken at a depth of from 22 to 24 feet below the surface, overlaid by sand and resting on clay. In this deposit of shell-bearing sandy mud the whole molluscan remains, so far as came under my notice, were so eroded that not one of the species could be determined, with the exception of *Pecten Islandicus*, which had, however, suffered much. In the same sample, most of the plates of *Balani* were in a fair state of preservation, but, at the same time, I do not think that the same species suffers relatively alike in the different localities of our clay-fields. One species may become the victim of a solvent in one locality, and another species of a different solvent in another locality.

Amongst the Carboniferous fossils the genus *Nucula* may hold the highest place in the same respect. It is a curious fact that some species of both Post-tertiary and Carboniferous invertebrata take on particular colours occasionally, while others retain persistently the same colours. Some species of the Post-tertiary ostracoda are often met with, having acquired different colours, most frequently brown and black of different shades, while all the others in the same clays approach their natural colours. On the other hand the Carboniferous ostracoda are sometimes found to vary in an opposite direction. The beautiful little ostracod *Beyrichia multiloba*, so far as I know, has seldom if ever been found of any other colour than white, while other ostracoda associated with it are all dark.

*Vegetable Remains.*—In the clays of Garvel Park these are in unusual abundance, associated with arctic shells, particularly high up in the section, and occupying from two to three feet of the dark, muddy sand overlying the tenacious clay, which abundantly contains seaweeds, mosses, seeds and other remains of vascular plants, which in some parts lie mixed together in small lenticular masses in the plane of bedding. In some cases small tufts of the finer seaweeds are met with deeper down in the sandy mud, but

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are never found, in a recognisable state, so far as I know, in the lower tenacious clay.

It is somewhat remarkable that they are chiefly confined to the western hollow or gully that extends across the excavation. Such gullies, however, on our present shores are well known to be receptacles or sheltering havens for drifting seaweed as well as for other materials brought down by river and streamlet. Indeed, our wonder at first is, that these seaweeds, etc., are not met with in greater abundance in the excavation of the Post-tertiary clays so as to correspond with what may be seen along our present shores. But it is to be remembered that the great bulk of such vegetable materials cast ashore or driven up into bights or lodged at the bottom of sheltered bays, are generally of the larger and softer kinds, which are more liable to decompose and less likely to retain their consistence till silted up, than the smaller and firmer in texture. It is reasonable to assume that rapid decomposition of these soft cellular plants is likely to be accelerated where they are largely heaped together. There can be no doubt that the decomposition of the larger seaweeds is in great measure the cause of the darker colour of the sandy mud in which the plant remains are found, and may in most cases account for the black lenticular masses which are, as stated, often met with in the Post-tertiary clays of the Clyde district. Those plants which can be identified are chiefly of the harder character referred to, such as *Desmarestia aculeata* and *Sphacelaria cirrhosa*, which constitute the great bulk of the recognizable plant remains met with in the Garvel Park clays. Amongst these remains there is, as we have said, a large number of seeds. These seeds are common in the Post-tertiary deposits, but their presence has not hitherto excited much attention, perhaps owing to the probability of many of them having been blown into, and mixed up with the clay quite recently, the difficulty of distinguishing such from those of older date, and the fact that while such doubts exist, little value can be attached to their study.

The soft cellular seaweeds are seldom found in a recognizable state in our Post-tertiary clays. So far as I know, Mr. James Bennie was the first to discover them in the brick clays of Paisley, while Mr. James A. Mahony afterwards worked out and published the results.* The deposit was at West Marsh brickfield, Paisley, and the position and character of the beds and plant remains

* *Proc. Nat. Hist. Soc. Glas.*, vol. i., p. 199.

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agree closely with those at Garvel Park. In both cases the seaweeds, mosses, and vascular plant remains were imbedded in a stratum of muddy sand overlying a more tenacious clay. There was this great difference, however, that in the sandy clay at Paisley no arctic shells were associated with the seaweeds, nor were there shells of any kind, with the exception of the Common Mussel (*Mytilus edulis*), whereas in the Garvel Park section arctic shells, such as *Pecten Islandicus* and *Tellina calcaria*, with their valves together in natural position as they had lived and died, were numerous.

An opinion has sometimes been expressed that the Common Mussel in our clays is of later date than the period of the glacial shells. The late Rev. W. Fraser, LL.D., of Paisley, endeavoured to prove that the clay-beds of Paisley are divided into certain continuous layers of uniform character, each with its peculiar fossils. He arranged the series thus :—

(1st) Boulder-clay.

(2nd) Laminated clay, generally shell-less and stone-less.

(3rd) Laminated clay with arctic and boreal shells.

(4th) Clay chiefly used for brick making, with no glacial shells, the last which disappears being *Cyprina Islandica*.

(5th) At the close of this series and on its surface appear patches of a well-known shell, *Mytilus edulis*, the Common Mussel.*

If these statements referred to one particular section we should not dispute their accuracy, but we venture to say that such is certainly not the general rule of the beds and fossil contents of the Paisley clay-fields, as will be acknowledged by any one who has had an opportunity of examining them with ordinary care. The brick-fields at Paisley cover only a small area, but even within that narrow boundary both the character of the beds and the sequence of the fossils alter greatly. The supposition that the Mussel appeared only in superficial strata subsequently to the disappearance of the glacial shells is certainly erroneous. Mussels are found in all parts of the section, and time need not be taken up in giving more than one or two examples from the many. In the pit opposite the Fire-clay works on the north side of Paisley, a thick bed of Mussels was met with at 14 feet below the surface, and under glacial shells. This was also the case in the railway cutting

* *Trans. Geol. Soc. Glas.*, vol. iv., pp. 178-9.

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under the Crow Road at Jordanhill, and at the neighbouring brick-works there.* In these cases the Mussel shells were abundant, with arctic shells overlying them. In short there appears to be no reliable grounds for the correlation of any shell or class of shells with any particular horizon from top to bottom of our glacial shell-bearing clays, further than what was consistent with their natural habitat, whether sand, gravel, mud, or depth of water. Every individual in the catalogue of the Clyde valley Post-tertiary glacial shells may be found at any part of the section from top to bottom.

Whatever time the shell-bearing clays represent or whatever vicissitudes may have occurred during that period, there appears to have been no change in the fauna whereby a line can be drawn to separate one portion from another anywhere between the Boulder-clay and the old Raised Beach.

After the above was written Mr. Robert Craig, Langside, Beith, brought under my notice that in sinking a pit at Warwickhills, Ayrshire, shells, which were identical with the glacial marine shells usually overlying the Boulder-clay in the West of Scotland, were met with in a bed of muddy sand 78 feet under Boulder-clay. On further examination of this bed, echinodermata, polyzoa, crustacea, foraminifera, and mosses, were found, being identical with those met with in the laminated clay resting on the Boulder-clay above referred to. This muddy sand-bed also contained a large proportion of West Highland rocks, which, we may reasonably assume, belong to the glacial period.

Another suggestive fact connected with this deposit is that this thin underlying fossiliferous bed does not show the least appearance of contortion or irregular bedding or displacement in any way caused by the overlying 78 feet of Boulder-clay, which seemingly has been laid down under the most tranquil conditions, such as, together with the fact that it rests on the undisturbed marine beds, could not possibly have taken place under land ice. Some years ago a similar deposit at Kilmaurs with marine shells, was described by the late Dr. Bryce,† with further details by Mr. John Young, F.G.S., and Mr. Robert Craig,‡ and there can be

* *Trans. Geol. Soc. Glas.* vol. iv. p. 241.

† *Quart. Journ. Geol. Soc.* vol. xxi. p. 213.

‡ *Trans. Geol. Soc. Glas.* vol. iii. p. 310.



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little doubt that these shell-beds under the Boulder-clay at Kilmaurs are an extension of those at Warwickhills.

Zones of littoral shells are met with at different elevations—at Jordanhill 60 feet above sea level; Arkleston 40 feet; Paisley 10 feet; from which we may infer that these clays were deposited during considerable changes of level, and between long intervals of time. Other fossiliferous clays are found at greater elevations, as we have already stated. In all these cases the shells, ostracoda and foraminifera, are identical with those of lower levels. It is true that on the East coast of Scotland, at Elie, Barrie, Montrose, &c., the fauna appears to be more arctic than on the West coast, indicating, apparently, the former prevalence of colder conditions on that coast than on this side of the island; conditions not easily accounted for, when we consider that the sea, at the time when the shell-bed at Chapelhall was under water, must have flowed freely between the Frith of Forth and the Frith of Clyde.

Without professing to account fully for the difference referred to, we would point out that many instances might be adduced of a greater difference in the present faunas within as narrow limits. In the present seas of our eastern and western coasts, as stated in a former paper,* we find the fauna of the one apparently much more arctic than that of the other. *Saxicava* (*Panopæa*) *Norvegica*, *Fusus Turtoni*, *F. Norvegica* and *F. Berniciensis*, all northern species, have been taken alive off the Durham and Northumberland coasts, while no trace of them has been found on our more northerly western shores.

Difference in temperature of particular parts of the sea, as shown by recent observations off the North of Scotland, may influence the fauna to some extent, yet it appears "that the ostracoda and foraminifera of the North-east coast of England do not present that marked arctic character which has been noticed in a considerable group of the Northumberland mollusca, but that there is, on the contrary, a marked absence of some typically northern forms which are abundant in the warmer seas of the western coasts. Nor can we suppose that a cold arctic current is the only, or even perhaps the chief agent, in the continued existence of this peculiar Northumbrian molluscan fauna, else we could scarcely fail to have had an equally well marked development of

* *Trans. Geol. Soc. Glas.* vol. v. p. 193.

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arctic types among other groups of invertebrata whose organisation renders them even more easy of distribution. We must, therefore, in the absence of more accurate information, look to some strictly local circumstances as having been the chief causes of the retention of the species in question over particular circumscribed areas."*

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*LISTS OF GENERA AND SPECIES.*

## PLANTÆ.

### ALGÆ.

Although some of the specimens are in a beautiful state of preservation, showing the structure of the plants as clearly as in the recent state, yet a number of others are so changed and imperfect that they cannot be satisfactorily referred either to their proper genus or species.

| | |
|---|---|
| *Desmarestia*, Lamour. | |
| *aculeata* Linn., | Very common. |
| *Dictyota*, Lamour. | |
| *dichotoma*, Huds., | Moderately common. |
| *Dictyosiphon*, Grev. | |
| *fœniculaceus*, Huds., | Moderately common. |
| *Sphacelaria*, Lyngb. | |
| *cirrhosa*, Roth., | Moderately common. |
| *Corallina*, Linn. | |
| *officinalis*, Linn., | Rare. |
| *Melobesia*, Lamour. | |
| *polymorpha*, Linn., | Rather rare. |
| *Peyssonelia*, Dne. | |
| *Dubyi*, Crouan, | Rare. |

### MUSCI.

Perhaps the most remarkable feature connected with the vegetable remains in the clays of Garvel Park is the large number of mosses found in it. The Rev. J. Fergusson, of Fern, Brechin, to whom I submitted specimens, says,—"Garvel Park will not only supply the largest number of species of Post-tertiary mosses ever gathered in one place, but a number about equal to all that have

* Brady & Robertson. *Report of Brit. Assoc. for* 1875.

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been collected in all the localities put together." With great care and ability he has identified 51 good species, 4 doubtful—a number being as yet left undetermined. Many of them are of rare occurrence and becoming more restricted in their distribution, such as *Hypnum Bambergeri*, very rare now in Britain, and confined to high altitudes; *Barbula aciphylla*, not British now, but occurring sparingly in Norway and more frequently on the alpine ranges of South Europe; and *Paludella squarrosa*, not rare in the Garvel Park clay, but now very rare, if not altogether extinct, as a recent species in Britain. The most abundant species is *Hylocomium splendens*, while others are represented by mere scraps, such as *Bryum pallens*, but generally they are more or less plentiful. Although the fragmentary state in which they are found shows that they have been subjected to some rough treatment, yet they mostly retain sufficient characters for identification. It is remarkable that among the large number of species not one of the common mosses belonging to the genus *Sphagnum* has been seen.* It may be mentioned that all the vegetable matter found in the section is confined chiefly to the upper muddy sand overlying the tenacious clay, occurring in layers, or rather in patches, and mostly connected by a thin extension of their edges on the same line of bedding, which is not always continuous, but has breaks here and there, more or less extensive. The spaces between the layers of vegetable matter vary from a few inches to a foot or two. Arctic shells, with their valves together, are found associated with these plant remains from top to bottom, but more of a shallow-water character, and smaller and more sparingly, above than below. It is a matter of wonder how so many species of mosses have been gathered together within so narrow an area, but wherever streamlets or rivers flow, we can understand how they may carry away vegetable matter from their banks to the sea, when it may be drifted up into some sheltered creek or gully, and, becoming water-logged, sink to the bottom, to be covered up by the mud and sand deposited. Their presence and abundance in such places as Garvel Park may not be exceptional, but they may have in some measure been hitherto overlooked. Since we now know of their profuse

* Since the above was written Mr. Fergusson tells me that there are two or three fragments of *Sphagnum* in the gathering, but that they are so minute, and impossible to identify as to species, that he will not insert them in the list.

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existence in this place, I have no doubt that in future they will be sought for and found in the muddy sands more frequently than formerly. The genera and species identified are as follows :—

| | |
|---|---|
| *Gymnostomum* (species ?). | |
| *Dichodontium pellucidum.* | |
| *Dicranum scoparium.* | Rare. |
| *Cynodontium virens*, var. *compactum*, | Frequent. Now rare in Scotland, where it is confined to the mountains. |
| *Distichium inclinatum.* | |
| *Trichostomum* (species ?). | |
| *Barbula fragilis.* | |
| ,, *tortuosa.* | |
| ,, *aciphylla.* | Not British now. Occurs sparingly in Norway, and more frequently on the Alpine Ranges of South Europe. |
| *Racomitrium lanuginosum.* | Abundant. |
| *Webera albicans.* | |
| *Bryum pseudotriquetrum.* | |
| ,, *pallens.* | |
| *Mnium subglobosum.* | Rare. |
| ,, *affine.* | |
| *Paludella squarrosa.* | Not rare. Now very rare if not altogether extinct in Britain. |
| *Aulacomnium palustre.* | Frequent. |
| *Philonotis fontana.* | |
| *Polytrichum juniperinum.* | Frequent. |
| ,, *strictum.* | |
| *Pogonatum alpinum.* | |
| *Antitrichia curtipendula.* | Frequent. |
| *Climacium dendroides.* | Abundant. |
| *Thuidium tamariscinum.* | Rare. |
| ,, *decipens.* | |
| *Brachythecum rivulare.* | |
| ,, *reflexum.* | |
| ,, *populeum.* | |
| ,, *salebrosum* (?). | |
| ,, *albicans.* | |
| *Camptothecium nitens.* | Frequent. |
| ,, *lutescens.* | Frequent. |
| *Eurhynchium piliferum.* | |
| *Plagiothecum denticulatum.* | |
| *Amblystegium* (species ?). | |
| *Hypnum elodes.* | |
| ,, *stellatum.* | |

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| | |
|---|---|
| *Hypnum giganteum.* | |
| ,, *sarmentosum.* | |
| ,, *Schreberi.* | |
| ,, *molle.* | Now confined to high altitudes, and rare in Britain. |
| ,, *cupressiforme.* | |
| ,, *callichroum.* | |
| ,, *Bambergeri.* | Now very rare in Britain and at high altitudes. |
| ,, *falcatum.* | |
| ,, *filicinum.* | Several forms. |
| ,, *aduncium.* | |
| ,, *Kneiffii.* | |
| ,, *fluitans.* | |
| ,, *revolvens.* | |
| *Hylocomium splendens.* | Abundant. |
| ,, *brevirostre.* | |
| ,, *squarrosum.* | Abundant. |
| ,, *triquetrum.* | |

## SEEDS OF VASCULAR PLANTS.

Seeds in this deposit are not uncommon. I submitted a gathering of them to Professor Bayley Balfour, who kindly prepared the subjoined list, but found the structural characters so imperfect that little more could be given with certainty than the genera to which some, and the orders to which others, belong.

1. Caryophylleæ, might be one of several genera.
2. *Isoetes* (?), ally.
5. An endocarp (?), composite (?), or umbellifer (?)
6. ? if allied to *Spayanina.*
9. Caryophylleæ or chenopodiaceæ (?).
11. *Rumex.*
12. *Chara* (female).
15. *Melilotus* (?).
19. Caryophylleæ—*Lychnis* (?).
20. *Plantago.*
22. *Scripus* or aff.
26. Endocarp of *Potamogeton* (?).
*b.* Composite—ally of *Latuca.*
*d.* Composite.
*g.* Caryophylleæ—? if spergule.
*l.* *Carex*, or perhaps *Polygonum.*

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## PORYPHORA.

### SPONGIDÆ.

*Cliona*, Grant.

*celata*, Grant. Common, burrowing into various species of shells.

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## RHIZOPODA.

### FORAMINIFERA.

It may be remarked that the foraminifera here have a great tendency to variation, and the following may serve as examples :— *Lagena apiculata* of Reuss, a smooth species, which is by no means common, occurs together with a striated form that we may call *L. apiculata*, var. *semi-striata*, which is very common. The same liberty may be taken with *L. gracillima* of Seguenza, and a striated form, which is greatly more common than the smooth typical species and *L. lævis*, Mont., with a turreted or scala variety.

| | |
|---|---|
| *Cornuspira*, Schultze. | |
| *foliacea*, Phillipi. | Rare. |
| *involvens*, Reuss. | Rare. |
| *Vertebralina*, | |
| *striata*. | Rare. |
| ,, var. | Rare. |
| *Biloculina*, D'Orb. | |
| *simplex*, D'Orb. | Rare. |
| *ringens*, Lamarck. | Common. |
| *depressa*, D'Orb. | Common. |
| *elongata*, D'Orb. | Moderately rare. |
| *Miliolina* Will. (*Triloculina*, D'Orb.). | |
| *oblonga*, Mont. | Moderately rare. |
| *tricarinata*, D'Orb. | Moderately rare. |
| *Miliolina* (*Quinqueloculina*, D'Orb.). | |
| *seminulum*, Lin. | Common. |
| *secans*, D'Orb. | Common. |
| *Ferrussacii*, D'Orb. | Rare. |
| *agglutinans*, D'Orb. | Moderately common. |
| *subrotunda*, Mont. | Moderately common. |
| *Spiroloculina*, D'Orb. | |
| *excavata*, D'Orb. | Rare. |
| *Hauerina*, D'Orb. | |
| *compressa*, D'Orb. | Moderately rare. |
| *Astrorhiza*, Sandahl. | |
| *cornuta*, Brady (? | Rare. |

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| | |
|---|---|
| *Sorosphœra*, Brady. | |
| *confusa*, Brady. | Rare. |
| *Technitella*, Norman (?) (species ?).* | |
| *Reophax*, Montfort. | |
| *fusiformis*, Will. | Rare. |
| *Trochammina*, P. and J. | |
| *squamata*, P. and J. | Moderately rare. |
| *Lagena*, Walker and Jacobs. | |
| *sulcata*, W. and J. | Common. |
| *costata*, Will. | Rare. |
| *Williamsoni*, Alcock. | Rare. |
| *striato-punctata*, P. and J. | Rare. |
| *lævis*, Mont. | Moderately rare. |
| *striata*, D'Orb. | Common. |
| ,, var. *turreta*. | Rare. |
| *semistriata*, Will. | Common. |
| *Haidingeri*, Czjzek. | Moderately common. |
| *apiculata*, Reuss. | Moderately common. |
| ,, var. *semistriata*. | Common in the muddy sand. |
| *distoma*, P. and J. | ,, ,, ,, |
| *gracillima*, Seg. | Rare ,, ,, |
| ,, var. *striata*. | Common ,, ,, |
| *lævigata*, Reuss. | Rather rare; new to Britain. |
| *globosa*, Mont. | Common. |
| *marginata*, W. and J. | Common. |
| *caudata*, D'Orb. | Rare. |
| ,, var. *striata*, P. and J. | Rare. |
| *squamosa*, Mont. | Moderately rare. |
| *melo*, D'Orb. | Rare. |
| *ornata*, Will. | Rare. |
| *Glandulina*, D'Orb. | |
| *lævigata*, D'Orb. | Rare. |
| *Nodosaria*, Lamk. | |
| *raphanistrum*, Lin. | Rare. |
| *Dentalina*, D'Orb. | |
| *communis*, D'Orb. | Moderately common. |
| *consobrina*, D'Orb. | Rare. |
| *pauperata*, D'Orb. | Rare. |
| *Cristellaria*, Lamk. | |
| *rotulata*, Lamk. | Rare. |
| *Polymorphina*, D'Orb. | |
| *acuminata*, Will. | Rare. |
| *lactea*, W. and J. | Common. |
| *gibba*, D'Orb. | Common. |
| *oblonga*, Will. (?) | Moderately common. |

* This is a small cylindrical bundle of tri-radiate calcareous spicules mixed with fine grains of sand, approaching to *Technitella*, but too imperfect to decide satisfactorily either as to genus or species.

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| | |
|---|---|
| *Uvigerina*, D'Orb. | |
| *pygmæa*, D'Orb. | Common. |
| *angulosa*, Will. | Rare. |
| *Spirillina*, Ehrenb. | |
| *vivipera*, Ehrenb. | Rare. |
| *Orbulina*, D'Orb. | |
| *universa*, D'Orb. | Moderately rare. |
| *Globigerina*, D'Orb. | |
| *bulloides*, D'Orb. | Rare. |
| *Verneuilina*, D'Orb. | |
| *polystropha*, Reuss. | Rare. |
| *Bulimina*, D'Orb. | |
| *marginata*, D'Orb. | Common. |
| *pupoides*, D'Orb. | Rare. |
| *aculeata*, D'Orb. | Rare. |
| *ovata*, D'Orb. | Moderately rare. |
| *elegantissima*, D'Orb. | Common. |
| *Bolivina*, D'Orb. | |
| *punctata*, D'Orb. | Moderately common. |
| *costata*, D'Orb. | Common. |
| *Cassidulina*, D'Orb. | |
| *lævigata*, D'Orb. | Rare. |
| *crassa*, D'Orb. | Moderately common. |
| *Discorbina*, P. and J. | |
| *globularis*, D'Orb. | Rare. |
| *rosacea*, D'Orb. | Rare. |
| *Planorbulina*, D'Orb. | |
| *Mediterranensis*, D'Orb. | Moderately rare. |
| *Truncatulina*, D'Orb. | |
| *lobatula*, Walker. | Moderately common in the upper sandy clay; very scarce or absent in the tenacious clay. |
| *Pulvinulina.* | |
| *canariensis*, D'Orb. | Rare. |
| *Rotalia.* | |
| *Beccarii*, Lin. | Common. |
| *nitida*, Will. | Rare. |
| *Patellina*, Will. | |
| *corrugata*, Will. | Common. |
| *Polystomella*, Lamk. | |
| *crispa*, Lin. | Common in upper sandy clay. |
| *striato-punctata*, F. and M. | Common. |
| *Nonionina*, D'Orb. | |
| *scapha*, Lin. | Common. |
| *turgida*, Will. | Rare. |
| *stelligera*, D'Orb. | Rare. |
| *depressula*, W. and J. | Moderately rare. |
| *asterizans*, F. and M. | Rare. |

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## ZOOPHYTA.

### HYDROIDA.

*Eudendrium*, Ehrenb.
*ramosum*, Ellis. A few fragments.
*Sertularia*, Lin.
*pumila*, Doody.
*filicula*, Hudson.

---

## ECHINODERMATA.

In this class spines and plates are numerous in the deposit, and belong to various genera which have not as yet been satisfactorily determined. Amongst the recognizable forms belonging to the various families are—

OPHIURIDÆ.

*Ophiura*, Lamk.
*albida*, Forbes.
*Ophiocoma*, Agassiz.
*bellis*, Link. Spines and plates common.

CIDARIDÆ.

*Echinus*, Lin.
*Dröbachiensis*, Müll. Very common; the spines and plates at some places in the muddy sand in great clusters, and frequently at the sides of stones.
*sphæra*, Müll. Rather rare; the plates of this species are generally larger, redder, and less disarticulated than those of *E. Dröbachiensis*.

SPATANGIDÆ.

Spines and plates moderately common in the muddy sand.

PSOLIDÆ.

*Psolus*, Oken.
*phantapus*, Lin. Scales found in great clusters in the muddy sand, chiefly at one point.

SIPUNCULIDÆ.

*Sipunculus*, Lin.
*Bernhardus*, Forbes (?). Their clay tubes moderately common in small spiral shells.

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## ANNELIDA.

SERPULIDÆ.

One of this family, which was first brought under my notice by Mr. Thomas Scott of Greenock, was also dredged in the Hebrides

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by Mr (now Dr.) J. Gwyn Jeffreys, and reported in the 36th Report of the British Association, 1866, by the late Mr. Joseph Alder. Mr. Alder describes it as "slender and strongly carinated through the greater part of its length, not unlike the common *Serpula triquetra*, but rather more slender. Near the mouth, however, there is a long bulbous swelling of the same substance as the shell, but rather less compact and more brittle; this terminates in a double arch in front. On examining its structure we find that this bulbous portion consists of two cells, divided from each other by a thin wall of shell, and that the triangular portion of the general body is confined through its base, with the mouth of the tube opening generally below it. In one instance, however, the tube is continued for a short distance in front of the swelling. Dr. Jeffreys thinks that this protuberance may be an egg-case, which I think is very likely, as there is a small external aperture in front of each partition, which apparently communicates with the tubular portion posteriorly. I am not aware that any similar structure has been before observed in the tubular annelids. The species appears to be a new one." I think that it might be very properly named *S. Alderi*.

| | |
|---|---|
| *Serpula*, Lin. | |
| *Alderi*, D. R. | Rare, attached to shells. |
| *triquetra*, Mont. | Moderately common. |
| *vermicularis*, Ellis. | Common, often in large clusters. |
| *Spirorbis*, Lamk. | |
| *communis*. | |
| *spirillum*, Lin. | |
| *Filograna*, Berk. | |
| *implexa*. | |

## CRUSTACEA.

### OSTRACODA.

Referring to the whole section at Garvel Park it would be difficult to say as regards this group, with few exceptions, what was rare and what common, as from the large extent of the cutting it was often found that the species rare or absent at one point were abundant at another.

| | |
|---|---|
| *Argillœcia*, G. O. Sars. | |
| *cylindrica*, G. O. Sars. | Rare. |

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| | |
|---|---|
| *Aglaia*, Brady. | |
| *glacialis*, B. C. and R. | Rare. |
| *Pontocypris*, G. O. Sars. | |
| *trigonella*, G. O. Sars. | Rare. |
| *Cythere*, Müller. | |
| *lutea*, Müll. | Common. |
| *viridis*, Müll. | Rather rare. |
| *pellucida*, Baird. | Common. |
| *castanea*, G. O. Sars. | Rare. |
| *porcellanea*, Brady. | Common. |
| *tenera*, Brady. | Rare. |
| *globulifera*, Brady. | Moderately common. |
| *tuberculata*, G. O. Sars. | Common. |
| *concinna*, Jones. | Common. |
| *angulata*, G. O. Sars. | Common. |
| *limicola*, Norman. | Moderately common. |
| *pulchella*, Brady. | Rather rare. |
| *villosa*, G. O. Sars. | Common. |
| *Dunelmensis*, Norman. | Moderately common. |
| *Cytheridea*, Bosquet. | |
| *punctillata*, Brady. | Common. |
| *papillosa*, Bosquet. | Moderately common. |
| *Sorbyana*, Jones. | Rare. |
| *Eucythere*, Brady. | |
| *Argus*, G. O. Sars. | Rather rare. |
| *Loxoconcha*, G. O. Sars. | |
| *impressa*, Baird. | Rare. |
| *tamarindus*, Jones. | Common. |
| *fragilis*, G. O. Sars. | Moderately common. |
| *Xestoleberis*, G. O. Sars. | |
| *aurantia*, Baird. | Rare. |
| *Cytherura*, G. O. Sars. | |
| *nigrescens*, Baird. | Common. |
| *Sarsii*, Brady. | Moderately rare. |
| *similis*, G. O. Sars. | Moderately rare. |
| *undata*, G. O. Sars. | Common. |
| *flavescens*, Brady. | Moderately common. |
| *clathrata*, Sars. | Rather rare. |
| *cellulosa*, Norman. | Rare. |
| *lineata*, Brady. | Moderately common. |
| *angulata*, Brady. | Common. |
| *cuneata*, Brady. | Common. |
| *striata*, G. O. Sars. | Common. |
| *Cytheropteron*, G. O. Sars. | |
| *latissimum*, Norman. | Common. |
| *nodosum*, Brady. | Common. |
| *angulatum*, Brady and Robertson. | Moderately common. |

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| | |
|---|---|
| *Bythocythere*, G. O. Sars. | |
| *simplex*, Norman. | Rather rare. |
| *constricta*, G. O. Sars. | Rare. |
| *Sclerochilus*, G. O. Sars. | |
| *contortus*, Norman. | Moderately common. |
| *Paradoxostoma*, Fischer. | |
| *variabile*, Baird. | Common. |
| *flexuosum*, Brady. | Rather rare. |
| *Polycope*, G. O. Sars. | |
| *orbicularis*, G. O. Sars. | Moderately common. |

### DECAPODA.

#### MACROURA.

Claws. A number of small claws were met with in the clays, and although too fragmentary to identify there can be no doubt that they belonged to members of the Macroura family.

#### ANOMOURA.

Claws and portions of carapaces. The claws were in great abundance, evidently of several species, of which the least doubtful one is *Pagurus Bernhardus*.

#### BRACHYURA.

*Hyas*, Leach.

*araneus*, Fabr. One specimen, nearly whole, between the valves of *Pecten Islandicus*, and sitting in its natural position.

*Cancer*, Lin.

*pagurus*, Lin. A portion of a carapace about 4 inches broad. This and the above species were discovered by Mr. Thomas Scott, and so far as I know are the only remains of Brachyurans as yet found in the Post-tertiary clays of Scotland.

### CIRRIPEDIA.

#### BALANIDÆ.

| | |
|---|---|
| *Balanus*, Lister. | |
| *crenatus*, Brug. | Moderately rare and small. |
| *porcatus*, Da Costa. | Common. |
| *Hameri*, Ascanius. | Moderately rare. |
| *balanoides*, Lin. | Moderately rare. |
| *Verruca*, Schumacher. | |
| *Strömia*, Müll. | Moderately common; adhering both to stones and shells. |

## INSECTA.

### COLEOPTERA.

A few legs and elytra of beetles, of at least two species, some of the elytra belonging to the genus *Otiorhynchus*, but too imperfect to allow of the species being determined satisfactorily.

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## POLYZOA.

In the following list Hincks' nomenclature has been followed.

| | |
|---|---|
| *Scrupocellaria scruposa*, Lin. | |
| ,, *scabra*, Van Beneden. | Rare. |
| ,, ,, var. *elongata*. | Moderately common. |
| ,, *reptans*. Lin. | Rare. |
| *Caberea Ellisii*, Flem. | Common. |
| *Membranipora lineata*, Lin. | Moderately common. |
| ,, *unicornis*, Flem. | Moderately common. |
| *Cribrilina annulata*, Fabr. (*Lepralia.*) | Rather rare. |
| *Porina tubulosa*, Busk. (*Lepralia.*) | Moderately common. |
| *Schizorporella sinuosa*, Busk. (*Lepralia.*) | Rather rare. |
| *Smittia Landsborovii*, Johnston. (*Lepralia.*) | Rather rare. |
| *Mucronetta Peachii*, Johnston. (*Lepralia.*) | Common. |
| *Crisia eburnea*, Lin. | Moderately common. |
| *Tubulipora flabellaris*, Fabr. | Moderately common. |
| *Idmonea Atlantica*, Forbes. | Rather rare. |
| *Lichenopora radiata*, Andouin. (*Discoporella.*) | Moderately rare. |

(And a few others too imperfect for identification.)

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## MOLLUSCA.

In the following list the nomenclature of Mr. (now Dr.) J. Gwyn Jeffreys has been followed.

### BRACHIOPODA.

#### TEREBRATULIDÆ.

| | |
|---|---|
| *Terebratula*, Lin. | |
| *caput-serpentis*, Lin. | Rare. |

### CONCHIFERA.

#### LAMELLIBRANCHIATA.

##### ANOMIIDÆ.

| | |
|---|---|
| *Anomia*, Lin. | |
| *ephippium*, Lin. | Common in the clays of the Clyde district. |
| ,, var. *squamula*, Lin. | Rather rare. |
| ,, ,, *aculeata*, Lin. | Moderately common. |

##### PECTINIDÆ.

| | |
|---|---|
| *Pecten*, Lamk. | |
| *Islandicus*, Müller. | Common. |

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MYTILIDÆ.

*Mytilus*, Lin.
*edulis*, Lin. — Rather rare.
*modiolus*, Lin. (*Modiola modiolus*, F. and H.) — Common.
,, Byssus and pearls.
*Modiolaria*, Beck.
*nigra*, Gray. (*Crenella nigra*, F. and H.) — Rare.

ARCIDÆ, Lowe.

*Nucula*, Lamk.
*nitida*, G. B. Sowerby. — Moderately common.
*tenuis*, Mont. (*Arca tenuis*, Mont.) — Rare.
*Leda*, Schumacher.
*pygmæa*, Munster. (*Nucula gibbosa*, Smith.) — Common.
( ,, *lenticula*, Möller.)
(*Portlandica lenticula*, G. O. Sars.)
(*Yoldia abyssicola*, Torell.)
*pernula*, Müller.
,, var. *mucilenta*, Steenstrup. — Moderately common.
*frigida*, Torell. (*Yoldia nana*, M. Sars.)
(*Portlandica frigida*, G. O. Sars.)

KELLIIDÆ.

*Lepton*, Turton.
*nitidum*, Turt. (*Kellia nitida*, F. and H.) — Rare.
*Montacuta*, Turton.
*bidentata*, Mont. (*Mya bidentata*, Mont.) — Moderately common.

LUCINIDÆ.

*Lucina*, Bruguière.
*borealis*, Lin. (*Venus borealis*, Lin.) — Rare.
*Axinus*, J. Sowerby.
*flexuosus*, Mont. (*Tellina flexuosa*, Mont.) — Common.
(*Lucina flexuosa*, F. and H.)
,, var. *Gouldii*, Phil. (*Axinus Gouldii*. G. O. Sars.)

CARDITIDÆ, Gray.

*Cyamium*, Phil.
*minutum*, Fabr. (*Venus minuta*, Fabr.) — Rather rare.
(*Tortonia minuta*, F. and H.)

CARDIIDÆ.

*Cardium*, Lin.
*echinatum*, Lin. — Rather rare.
*exiguum*, Gmelin. (*C. pygmæum*, F. & H.) — Rather rare.
( ,, Donor.)
*fasciatum*, Mont. — Moderately common.
*edule*, Lin. — Rare.
*Norvegicum*, Speng. — Rare.

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CYPRINIDÆ, Geinitz.

*Cyprina*, Lamk.
*Islandica*, Lin. — Common.
*Astarte*, J. Sowerby.
*sulcata*, Da Costa. (*A. Dammoniensis*, Mont.) Rare.
(*Pentunculus costatus*, Da Costa.)
(*Astarte scotica*, Mat.)
,, var. *elliptica*, Brown. — Common.
*compressa*, Mont. (*Venus compressa*, Mont.) Common.
,, var. *globosa*, Müll. — Rare.
,, ,, *striata*, Müll. — Rather rare.
(*Nicania striata*, Leach.) Rare.
*borealis*, Chemn. — Rather rare.
*triangularis*. — Rare.

VENERIDÆ, Leach.

*Venus*, Lin.
*casina*, Lin. — Rare.
*striata*. — Rare.
*Lucinopsis*, Forbes and Hanley.
*undata*, Penn. (*Venus undata*, Penn.) Rare.

TELLINIDÆ, Latreille.

*Tellina*, Lin.
*calcaria*, Chemn. (*T. lata*, Gmel.) Common.
(*T. proxima*, Brown.)
(*Macoma calcaria*, G. O. Sars.)
*balthica*, Lin. (*T. solidula*, F. and H.) Rare.
(*Macoma balthica*, G. O. Sars.)
*fabula*, Gronovius. — Rare.

MACTRIDÆ, Fleming.

*Mactra*, Lin.
*elliptica*, Brown. (*M. elliptica*, G. O. Sars.) Rare
(*M. solida*, var. *elliptica*, Jeffreys.)
*Scrobicularia*, Schumacher.
*alba*, Wood, (*Mactra alba*, Wood.)
(*Syndosmya alba*, F. and H.)
(*Abra alba*, G. O. Sars.) Moderately common.
*prismatica*, Mont. (*Ligula prismatica*, Mont.) Rather rare.
(*Syndosmya* ,, F. and H.)
(*Abra* ,, G. O. Sars.)

SOLENIDÆ, Latreille.

*Solen*, Lin.
*ensis*, Lin. — Fragment only.

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ANATINIDÆ, D'Orbigny.

*Thracia*, Leach.

*papyracea*, Poli. (*Tellina papyracea*, Poli.) Rare.
(*Thracia phaseolina*, F. and H.)

CORBULIDÆ.

*Corbula*, Brug.

*gibba*, Olivi. Rare.

MYIDÆ, Fleming.

*Mya*, Lin.

*truncata*, Lin. Rather rare.

SAXICAVIDÆ, Swainson.

*Saxicava*, Fleurian de Bellevue.

*Norvegica*, Spengler. (*Panopœa Norvegica*, F. and H. and G. O. Sars.) Rather rare.

*rugosa*, Lin. (*Mytilus rugosa*, Lin.)
(*Saxicava pholadis*, Lin. and G. O. Sars.)

,, var. *Arctica*, Lin. (*Saxicava Arctica*, G. O. Sars, and F. and H.) Rather rare.

PHOLADIDÆ, Gray.

*Pholas*, Lister.

*crispata*, Lin. (*Zirphœa crispata*, G. O. Sars.) Rare; mostly fragmentary.

## GASTEROPODA.

### CYCLOBRANCHIATA.

CHITONIDÆ.

*Chiton*, Lin.

*ruber*, Lin. *C. ruber*, F. and H. Rather rare.
(*Boreochiton ruber*, G. O. Sars.)

*marmoreus*, Fabr. (*Boreochiton marmoreus*, G. O. Sars.) Common.

*cinereus*, Lin. Rare.

### PECTINIBRANCHIATA.

PATELLIDÆ, Guilding.

*Helcion* (De Mont.), Jeffreys.

*pellucidum*, Lin. (*Patella pellucidum*, F. and H.) Rare.
(*Nacella pellucida*, G. O. Sars.)

*Tectura*, Cuvier.

*virginea*, Müll. (*Patella virginea*, Müll.) Common.
(*Acmœa virginea*, F. and H.)

FISSURELLADÆ, Fleming.

*Puncturella*, R. T. Lowe.

*Noachina*, Lin. Common.



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TROCHIDÆ, D'Orbigny.

*Trochus*, Rondelitius.

*helicinus*, Fabr. (*Margarita helicinus*, Leach. and G. O. Sars.) Moderately common.

*Grœnlandicus*, Chemn. (*Trochus undulatus*, F. and H.) Mod. common. (*Margarita grœnlandica*, G. O. Sars.)

*tumidus*, Mont. (*Gibbula tumida*, G. O. Sars.) Common.

*cinerarius*, Lin. ( ,, *cineraria*, G. O. Sars.) Rather rare.

*umbilicatus*, Mont. Rare.

*magus*, Lin. Fry. Rare.

*Mölleria*, Jeffreys.

*costalata*, Möller. Locally moderately common.

LITTORINIDÆ, Gray.

*Lacuna*, Turton.

*divaricata*, Fabr. (*Trochus divaricata*, Fabr.) (*Lacuna vincta*, F. and H.) Common and large.

*puteolus*, Turton, (*Turbo puteolus*, Turton.) Rare.

*Littorina*, Ferussac.

*obtusata*, Lin. (*Turbo obtusatus*, Lin.) (*Littorina littoralis*, F. and H.) Rather rare.

*limata*, Loven. (*L. arctica*, Möll.) (*L. palliata*, Say.) Moderately rare.

*rudis*, Maton. (*Turbo rudis*, Maton.) Moderately rare.

,, var. *sulcata*. (*Turbo sulcatus*, Leach.) Rare.

,, ,, *saxatilis*, Johnston. Rare.

*littorea*, Lin. (*Turbo littoreus*, Lin.) Very common in upper strata.

*Rissoa*, Freminville.

*parva*, Da Costa. (*Turbo parvus*, Da Costa.) (*Rissoa interrupta*, G. O. Sars.) Rather rare.

,, var. *interrupta* ; var. *bifasciata*, G. O. Sars. Very common.

*striata*, Adams. (*Onoba striata*, G. O. Sars.) Common.

,, var. *Arctica*, Lovén. (*Onoba aculeus*, Gould.) Rather rare.

,, ,, *giganticum*, Robertson. Single specimen.

*reticulata*, Mont. (*Rissoa Beanii*, F. and H.) Rare.

*costata*, Adams. Rare.

SKENEIDÆ, Clark.

*Skenea*, Fleming.

*planorbis*, Fabr.

*Homalogyra*, Jeffreys.

*atomus*, Philippi. (*Truncatella atomus*, Phil.) (*Skenea nitidissima*, F. and H.) Moderately rare.

PYRAMIDELLIDÆ, Gray.

*Odostomia*, Fleming.

*unidentata*, Mont. (*Turbo unidentata*, Mont.) Moderately common.

*spiralis*, Mont. (*Parthenia spiralis*, G. O. Sars.) Rare.

*indistincta*, Mont. (*Turbo indistincta*, Mont.) (*Chemnitzia indistincta*, F. and H.) Rare.

*interstincta*, Mont. (*Parthenia interstincta*, G. O. Sars.) Rare.

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NATICIDÆ, Swainson.

*Natica*, Adanson.

*affinis*, Gmel. (*Nerita affinis*, Gmel.) (*Natica clausa*, Brod. and Sow.) — Moderately common.

*Grœnlandica*, Beck. (*N. pusilla*. F. and H.) (*Lunatia Grœnlandica*, G. O. Sars.) — Moderately common.

VELUTINIDÆ, Gray.

*Velutina*, Fleming.

*lævigata*, Penn. (*Helix lævigatum*, Penn.) — Rare.

CANCELLARIIDÆ, Forbes and Hanley.

*Trichotropis*, Brod. and Sow.

*borealis*, Brod. and Sow. — Rare.

*Fusus*, Bruguière.

*antiquus*, Lin. (*Murex antiquus*, Lin.) — Moderately common.

APORRHAIDÆ, Troschel.

*Aporrhais*, Da Costa.

*pes-pelecani*, Lin. (*Strombus pes-pelicani*, Lin.) — Rare.

CERITHIIDÆ, Fleming.

*Cerithium*, Adamson.

*reticulatum*, Da Costa. (*Strombiformis recticulatus*, Da Costa.) — Moderately common.

*perversum*, Lin. (*C. adversum*, F. and H.) — In upper sandy bed. Rare.

BUCCINIDÆ, Fleming.

*Purpura*, Bruguière.

*lapillus*, Lin. (*Buccinum lapillus*, Lin.) (*Polytropa lapillus*, G. O. Sars,) — Rare.

*Buccinum*, Lin.

*undatum*, Lin. — Moderately rare.

MURICIDÆ, Fleming.

*Trophon*, De Mont.

*truncatus*, Ström. (*Buccinum truncatum*, Ström.) (*T. clathratus*, F. and H.) (*Tritonium clathratum*, Fabr.) — Moderately common.

*clathratus*, Lin. (*Trophon scalariformis*, Gould.) — Frequent.

,, var. *Gunneri*, Lovén. — Rare.

*Fusus*, Bruguière.

*antiquus*, Lin. (*Murex antiquus*, Lin.) — Moderately common.

PLEUROTOMIDÆ, Lovén.

*Defrancia*, Miller.

*linearis*, Mont. (*Murex linearis*, Mont.) (*Mangelia linearis*, F. and H.) (*Clathurella linearis*, G. O. Sars.) — Rare.

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*Pleurotoma*, Lamk.

*pyramidalis*, Ström. (*Fusus pleurotomarius*, Couthouy.)
(*Defrancia Vahlii*, Beck.) Moderately common.
(*Bela pyramidalis*, G. O. Sars.)

*nebula*, Mont. (*Murex nebula*, Mont.)
(*Mangelia nebula*, F. and H.)

,, var. *elongata*, Jeffreys. Rare.

*turricula*, Mont. (*Mangelia turricula*, F. and H.) Moderately common.

*Trevelyana*, Turt. ( ,, *Trevelyana*, F. & H.) Rare.
(*Bela* ,, G. O. Sars.)

*violacea*, Migh. (*Defrancia cylindracia*, Möll.) Rare.
(*Bela violacea*, G. O. Sars.)

*Cyprœa*, Lin.

*Europœa*, Mont. (*Trivia Europœa*, Sars.) A fragment.

## PLEUROBRANCHIATA, Gray.

### BULLIDÆ, Clark.

*Cylichna*, Loven.

*alba*, Brown. (*Volvaria alba*, Brown.) Moderately rare.

*Utriculus*, Brown.

*hyalinus*, Turt. (*Bulla hyalina*, Turt.) Common.
(*Amphisphyra hyalina*, F. and H.)
(*Bulla debilis*, Gould.)
(*Diaphana hyalina*, G. O. Sars.)

*obtusus*, Mont. (*Bulla obtusus*, Mont.) Common.
(*Cylichna* ,, F. and H.)

*truncatulus*, Brug. (*Cylichna truncata*, F. and H.)

,, var. *Lajonkairiana*, Basterat. Rare.

*mammillatus*, Phil. (*Cylichna mammillata*, F. and H.)

*Philina*, Ascanius.

*scabra*, Müller. (*Bulla scabra*, Müll.) Rare.
( ,, *granulosa*, M. Sars.)

*Vertigo*, Müll.
*edentata*, Drab.
*Cochlicopa*, Risso.
*lubrica*, Müll.

These two waifs of land shells have evidently been carried into the deposit the same as the mosses, &c.

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## VERTEBRATA.

### PISCES.

Vertebræ and otolites of fish are not uncommon.

### AVES.

A few small bones have been found.

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It is doubtful whether a few species of shells found in the top sandy layer, although associated with arctic shells, belong to the Post-tertiaries or have been washed in from the old Raised Beach, seen at a short distance overlying the true Post-tertiary clay. They are *Venus casina*, *V. striata*, *Rissoa costata*, *Solen ensis*, and *Cyprœa Europœa*. I am indebted to Mr. T. Scott, of Greenock, for several additions to this list.

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## II.—Some Notes on a Recent Trip in Ireland, and Thoughts Suggested by Them. By James White.

[Read 14th October, 1880.]

Having a few days to spare in the month of July, I bethought me of a ramble in Ireland, and taking ship, I landed at Sligo on the north-west coast, finding myself at once on the Carboniferous limestone, the uppermost of the hard rocks in that neighbourhood, and which is immediately overlaid by deposits of quaternary age.

On a reference to the geological map, it will be seen that, speaking roughly, Ireland consists of a great central plain, girdled with rocks of lower palæozoic age. This central district, which forms about one-half of the whole area of the island, is a very noticeable feature in the physical geography of the country, and is well seen on the railway journey from Sligo to Dublin, where, in many places, as far as the eye can reach on either side, there is neither hill nor even hillock to be seen, nothing but a country so uniformly flat that, but for its colour, you might take it for the sea, with sluggish rivers and peat bogs, which are neither few nor far between. Throughout the whole extent of this great plain, with the exception of a few patches, the uppermost rock is Carboniferous limestone, as might be guessed from the fact that it is used for all the buildings, public and private, the bridges, the roadside and field dykes, and even for metalling the roads. Its peculiar fossils—corals, encrinites, and shells—may be seen weathered out wherever there is an exposed surface. I now exhibit a specimen of this limestone from Ballysadare, a small town about five miles south of Sligo, where there is a very large quarry supplying all the building stone for the neighbourhood. The rock is very

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compact, and is cut and dressed exactly as our home sandstones are. This piece contains a very good specimen of *Productus punctatus*—a brachiopod with which we are familiar in Scottish Carboniferous limestone—also numerous stems of encrinites and fragments of shells. It is a very pure limestone, though dark in colour, which is not due to any earthy impurities, but to carbon probably derived from the bodies of animals which lived and died in the seas where it was formed.

This Carboniferous limestone, the mountain limestone of the text-books, so called from its physical position in England, occupies a well marked horizon in the Carboniferous system. Dr. Page describes it as "forming in the rocky crust a zone so marked and peculiar that it becomes a guiding post both to the miner and to the geologist—its peculiar corals, encrinites, and shells distinguishing it at once from all the other strata."

In Western Scotland it is best seen in the district around Beith, and it gives its name to one of the four recognised divisions of our Scottish Carboniferous system. A similar order of succession to the Scottish series, with variations in detail, prevails elsewhere—one of the most noted of these variations being the enormous development in England and Wales of the equivalent of our uppermost division, or upper coal measures. In Scotland, in the valley of the Clyde at Uddingston, where they attain their greatest thickness, these measures do not exceed in all about 1,500 feet, whilst in North Staffordshire they reach 5,000 feet, and in the great coalfield of South Wales the formation is 10,000 feet in thickness.

In Ireland all this is reversed, there being there nothing but the merest shreds and patches of the upper coal measures, and none of the higher beds. This difference between the two islands is too striking, both geologically and economically, to have escaped observation, and the questions are suggested to the geologist—Whence has this difference arisen? Were the true coal-bearing strata never formed over the whole Irish central area, or were they at one time continuous and subsequently removed by denudation?

In his recently published work on the Geology of Ireland, Professor Hull goes very fully into this question; and discussing the great central area as a "plain of marine denudation," he shows (1st) That from the unvarying sequence of the strata forming the Carboniferous system in Great Britain, given the basement beds of

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the mountain limestone, the higher members of the system always are, or have been, present. (2nd) That, from the actual remains of those beds, outliers, which are found in different parts of the island, preserved by their physical situation, and which, though far apart, show a succession of beds agreeing precisely with each other, and with the strata of the English coal measures down to the most minute details, the evidence is conclusive that the Carboniferous system at one time covered four-fifths of the entire area of what is now known as Ireland. (3rd) That at the time of its formation Great Britain and Ireland were united, but that the latter, being raised above sea level, while the remainder was still left beneath the waves, was exposed for a long period of time to the action of those silent and slow but most potent forces—wind, rain, frost, and the action of the sea and ice—the result being, her coal measures being nearly all denuded away, Ireland lost all that mineral wealth which was left to England and Scotland in their Upper Carboniferous rocks. This physical difference between the two islands has had, and no doubt still has, a very considerable influence on the character and condition of their respective peoples, for if Ireland had that store of mineral wealth fortunately preserved to us on this side of the Channel, there would doubtless be amongst her people more prosperity and more peace.

In Hunt's Mineral Statistics for 1870 the following figures are given as the total produce of the Irish coal mines for that year—141,470 tons—a total which contrasts strangely with the 14,934,553 tons in the Scottish, and the 95,355,169 tons of the English production in the same period. In 1880 the proportions were—

| | |
|---|---|
| Ireland, - - - - | 133,719 tons, |
| Scotland, - - - | 18,274,886 „ |
| England, - - - | 128,069,917 „ |

Some writers indulge in pleasing fancies as to the design and purpose of these geological phenomena. They point to our coal-fields with their rich stores of mineral wealth, and to the way in which they have been preserved, as examples of the boundlessness of that Providential care which stored up these treasures for the future use of man, but they do not explain the reasons why such enormous spaces have been denuded of their coals and other mineral wealth, the proportional area of such denudation being apparently very much greater than the portions remaining intact.

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Verily, we are yet a long way from solving the riddle of Providence.

Four miles south of Sligo there is a ridge of low hills, running east and west, and marked on the map as of Silurian age, and at this point the railway cuts through them. At one place the rocks seemed to be a granite, and in others a banded gneiss, the one passing gradually into the other. Such is not uncommon in metamorphic districts where a sedimentary rock passes through various stages or degrees of metamorphism until it terminates in granite, which is thus evidently only the completion of the metamorphic process. In some geological works examples are given where sedimentary strata pass insensibly into porphyry. One notable example is that where in South America Mr. Darwin traced a conglomerate, a purely sedimentary shore deposit, till it passed by slow degrees of alteration into a rock which was quite distinctly of a porphyritic character. These rocks, granite and porphyry, are usually classed as purely igneous rocks, meaning by that a portion of the erupted or intruded magma of the globe, hitherto unexposed. But such examples show that in some cases at least they are not so, but are merely resolved sediments, and raise the whole question as to whether all eruptive rocks, granite in veins, traps, or felstone dykes, or even modern lavas, are not after all resolved from matter which has formerly existed in the shape of sedimentary rocks. Mr. Green, in his lately published work,* devotes several chapters to the discussion of these questions, and seems to think that there is a great probability that they will be settled affirmatively. If future investigation confirms these opinions, the beginning of the world is set further back than ever, as we are not left with a single rock to indicate its base.

Connected with the formation of granite, there is a feature which has always appeared to me to be of the greatest interest, from its bearing on another subject, to which I shall now take the liberty of diverging for a few moments. In the 14th volume of the Geological Society's Quarterly Journal, Mr. Sorby has a very elaborate memoir on the formation of quartz crystals. He comes to the conclusion that to give the pressure necessary for their formation, any rock containing them must have been formed in the crust of the earth at depths varying according to the structure of

* "Geology for Students and General Readers," by A. H. Green, Lond., 1880.

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the crystal, from 15,100 to 65,500 feet, or taking the mean depth of 40,300 feet or 7½ miles. These figures are quoted and accepted as trustworthy by Professor Ramsay. Let us see what they mean. That wherever a true crystalline granite is exposed at the surface of the earth there has been denudation of the superincumbent mass to the extent of 7½ miles.

Probably no subject in any department of thought has in recent times excited so keen an interest generally over the whole civilised world as the modern scientific doctrine of the continuity of life. Its discussion, originating in scientific circles, has overspread everywhere, until there is not a literary club which has not discussed it or a magazine which has not given it prominence from one point of view or another. Its points of contact are universal, and so is the interest felt in it; it lies at the root of all that restlessness and uneasiness of thought and opinion which prevail in quarters by no means geological, and of which our daily newspapers give us such copious details. It is, however, silently and slowly but surely influencing thought to an extent which cannot eventually be but for good.

One of the strong points, indeed *the* strong point, relied on by its opponents, from a geological point of view, is the fact that the record of life on the earth is not continuous, that palæontology does not show a constant succession of living forms graduating into each other, but that there are many and serious gaps, life-breaks, and interruptions which there is nothing to bridge over, horizons where numerous animal remains are found without any evidence of having any predecessors. These, they maintain, are fatal to the doctrine of continuity, and they adduce them as evidence, positive proofs of distinct platforms of creation when a power was put forth which we have no means of scrutinizing. Some American authors carry this out into great detail, and attempt to tabulate an order of succession based upon a limited number of such platforms.

What does the physical history of the earth say to such objections? We have seen the great amount of denudation which has taken place both horizontally and vertically over the highly fossiliferous Carboniferous system in Britain—the whole of the Irish Sea being cut out of it. What amount, therefore, of fossil-bearing strata has been removed! Their number and extent must have been enormous. However startling it may be to the uninitiated, or to those who have been unaccustomed to consider such questions, I

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think there is no other alternative than to accept the teachings on this point of the distinguished physicist and geologist whose names I have already quoted, that over every granitic region on our globe 7½ miles vertical of strata have been removed, much of them according to all analogy being fossiliferous, an amount of denudation which is fully confirmed by the testimony of the rocks elsewhere, the Upper Cretaceous and Wealden rocks of the south of England bearing evidence of the loss of many cubical miles. In truth, every formation is just made up from the debris of those which preceded it—sandstone wears down into sand again, which once more becomes compacted into solid rock; schist and shale and slate are once more mud, to become schist and shale and slate again; shelly limestone and coral reefs become lime once more, to be replaced as they were by the action of innumerable myriads of organisms; crystalline rocks are ground down to sediment to become crystalline rocks again—and thus the cycle of change goes on, and has gone on, since the first drop of rain was condensed on the surface of the earth.

The stratified rocks composing the earth's crust are, therefore, not a continuous series. They are a wreck, a ruin—a part, not a whole—a fragment, a series of fragments—broken, distorted, tattered. We have no continuous rocks, and, therefore, we have no continuous fossils—life-breaks, gaps, and interruptions being the necessary result of the physical history of our globe. As of sedimentary strata the lowest are always the oldest, so with the lowest organic life, the oldest is always the simplest, the least differentiated, the least specialised. The general order of succession is beyond all question from the simpler to the more complex—foraminifera, molluscoida, mollusca, pisces, reptilia, aves, mammalia. Nay, in some instances direct descent can be traced; Professor Huxley traces the horse from the bottom of the Tertiary system; Mr. Lapworth shows the gradual passage from one form to another of his Silurian graptolites; while Professor Marsh is following in the same line with the intermediate birds of the Cretaceous system. All this in the merest infancy of research! They have a hard task before them who contend for special creations, a task which is every year becoming harder.

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## III.—Notes on several New Forms of Graptolites from the Silurian Shales of Dumfriesshire. By James Dairon.

[Read 4th November, 1880.]

About three years ago, whilst engaged amongst the upper series of the graptolitic shales in one of the three scaurs which are deeply cut into the hillside near Polmoody Burn, and not far from Dobs Linn and the Grey Mare's Tail, I obtained a piece of shale having a peculiar glistening or lustrous appearance. On further examination, I found it to be one solid mass of graptolites of various species, the more noticeable of which were *Monograptus lobiferus* with a small number of *M. Sedgewickii*. The whole of their stipes or stems appeared to have been growing upwards in a branching form, and to have been rooted or fixed to the sea bottom. Probably by some sudden cause they have been turned on one side and covered over with the black mud now forming the shale, and thus they have preserved, as nearly as possible, their normal form and appearance. On the slab they can easily be seen spreading out from the main stem, and as, with a knife, the slab can be split into thin flakes $\frac{1}{32}$ of an inch in thickness, every new surface shows a new layer of organisms, with their branches all growing in one direction, I think the fixed nature of their habit of life is thus proved incontestably.

The possession of the first slab I obtained aroused an anxious desire in my mind to discover some more perfect specimens, and this I was fortunate enough to do, as also to procure a number of similar forms from Garpel Glen and Dobs Linn, while from these localities I also obtained a variety of genera and species which seem to be new, as I have not as yet seen them either figured or described anywhere.

For a considerable length of time I have been convinced that many of the species of graptolites found in the Moffat shales grew with a rooted or fixed attachment to the sea bottom, and that the specimens usually obtained are mere portions which, from various causes, were broken off from the parent stem, and, after floating

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about for a time fell to the bottom, and were buried in the black muddy deposit which has now for long ages preserved them. The many examples I now possess and the study I have given them quite confirm me in this belief.

It is not, however, an original idea, as Professor James Hall, of New York, expresses a similar view in his great work on the Graptolites of Canada, though it must not be forgotten that the graptolitic shales of Canada are much older than those of the South of Scotland, and belong to the Arenig series, or the equivalents of the Skiddaw slates, and consequently contain a different class of fossil remains from those of the Moffat shales. At the end of a chapter Professor Hall thus sums up—"We admit, therefore, that the family of Graptolitidæ, as now extended, may include both free and fixed forms;" but some other observers look rather unfavourably on the view that any of the graptolites were fixed bodies.

There can, however, be no doubt that most of the Diplograptidæ must have lived as free floating organisms, as they seem to be entirely devoid of any point of attachment whatever. In Professor Nicholson's lately published monograph on British Graptolites, of which only the first part has as yet appeared, he says—"In the genus *Rasterites* the nature of the base is not known, no example having been yet discovered in which the proximal extremity is exhibited. Judging from analogy, however, there is every reason to think that the base was slender and curved, as in *Graptolithus sagitarius*. It is, therefore, most probable that *Rasterites* could not at any time have been attached by its base." Now, though I am aware that this genus is generally found only in fragments, I have examples whole and in groups, with their extremities complete, and apparently as perfect as when they were first developed, as Professor Nicholson supposes, with a slender curved base and a spine at the proximal extremity. But independently of this some of my examples show that *Rasterites* did not seem to require any object of attachment, at least in all cases; two or three slabs showing a fibrous or hair-like substance which is associated with the organisms, apparently keeping them bound together. If such was the case it could only be those portions which outgrew the fibrous mass which could have been broken off and become detached and set free from the lower stems. To all appearance *Rasterites* would be easily severed, as they have only a stipe with the cellules independent of each

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other, standing up mostly at right angles, whereas the *Graptolites* have a strong stipe, cœnosarc, and cellules more or less overlapping one another, which consequently must have rendered them much stronger and not so easily injured or broken.

Further investigation has shown me that this delicate fibrous structure is sometimes connected with other species, as I have found it associated with *Monograptus tenuis*, *M. Sedgewickii* and *M. lobiferus*. Possibly, therefore, these fine filaments may be the young of the different species with which we find them associated. I believe I can detect the denticles or cellules budding out from them. They also appear to be formed into clusters, and fixed to some object. I have found one fixed or rooted on the periderm of a graptolite.

I will now draw your attention to a tablet with four specimens (marked 1 to 4) all of the branching form, all belonging to the same slab, and being small, the more easily unravelled. I would especially direct your attention to No. 2, the stipes or stems of which are branching out quite naturally, and also growing up in one direction, not in the least as if they had been at any time broken or tossed about. The cells are very variable in shape, size, and character, and many of them appear to have cellules on both sides of their stipe, as in the Diplograptidæ. There is also a much larger example of the same species with which portions of totally different forms have got mixed up, and the upper parts of the stems have been broken off. The cells of this specimen are tolerably distinct in character, and show about 20 per inch in length. These were undoubtedly fixed forms, and were found in Garpel Glen, near Beattock. Another very interesting small specimen of the branching form has the polypary of quite an unusual character; the branches are straight and stiff-looking, some of them broken, and a few small portions are lying by their side. The base or radicle is broken off from one side of the slab, but remains no doubt on the other uncovered side, underneath a piece of the shale which is higher. The specimen has the diprionidian character, with a slender stipe, and has about 12 cellules per inch in length. Another slab contains clusters of what appear to be *Monograptus tenuis*. Connected with them are substances which may have been roots having sheaths in them, which could hold the very delicate and slender initial points. There are also a number which seem to have been

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cast off from the groups and left free. Another slab contains the same species as the above, but under different conditions, and having the fibrous portions, previously spoken of, abundantly attached. I hope that, attention having been called to it, some more definite knowledge may now be obtained of this as yet undetermined fibrous or hair-like structure.

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## IV.—Notes on the Igneous Rocks of the Kilmalcolm District. By Arthur Pratt.

[Read 9th December, 1880.]

After passing through the village of Kilmalcolm by the road to the north-east, which passes the manse and winds up the hill, we come on the right hand to a quarry in an igneous rock which is wrought for road metal, and for rubble for building purposes. The rock is of a highly ferruginous character, and so abundant is the peroxide of iron that the clothes of the workmen and every tool, whether of wood or of metal, and even the roads, are all tinged strongly with red. It is worked in two sections, the lower one being redder in colour than the upper, and very much shattered into angular blocks of all sizes, which apparently require very little blasting to dislodge them.

The lower post is about 20 feet thick, and is principally of useful material, intermixed with patches of a very curious amygdaloid, which has cavities filled with the green mineral known as delessite, some being above an inch in diameter. In the larger drusy cavities many fine specimens of stilbite, mesotype, and analcime, in free crystals, are found lining the sides. On the top of this seam lies a bed of a very different amygdaloid, from one to two feet thick, in which the cavities are small, and lined with analcime and other minerals. Many of these cavities are still hollow, and are lined with clear crystals, which have smaller crystals of specular iron encrusted over them. Above the amygdaloid is a bed of very red volcanic ash, coloured with peroxide of iron. It is about three feet thick, and contains fragments of the prevailing rock of various sizes.

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Going round by the road we can get at the upper section, which is much the same in composition as the lower, but slightly darker in colour, and without any of the amygdaloidal cavities which are so abundant in the former. It is about 15 feet in thickness, and, like the other, very much shattered. This rock is described in the Geological Survey maps as melaphyre, but not having seen this rock previously, I took it for a felstone.

Melaphyre may be defined as a fine-grained, compact, black, greenish-black, or brownish-black aggregate of plagioclase, augite, olivine, magnetite, or titaniferous iron, and delessite or chlorophæite. The two last constituents are believed to distinguish melaphyre from basalt. In Prof. Zirkel's Report to the United States exploration of the Nevada mountains of Western America, he describes this rock as exactly as if he had been speaking of the Kilmalcolm melaphyre. He says:—"Most of the melaphyres are characterised by the absence of easily distinguishable microscopical ingredients, by their seemingly homogeneous mass of a dirty greenish or brownish colour, and by the presence of amygdaloidal calcite or green earth delessite. Self-existing amygdules of quartz or other silicious matter seem not to be frequent. Such secretions, which here often reach the dimensions of a hazel nut, are, as is well known, derived primarily from the decomposition of the augitic constituent. These micro-petrographical points give the rock a certain degree of difference from common traps, and stamp it with some peculiarity, which is the only apology for using the unfortunate name melaphyre to classify them."

Further on he says:—"So it has happened that for half a century all rocks whose constituents it has been found impossible to determine microscopically have been named melaphyre."

This is a very interesting locality in its physical features. In going up the road already mentioned one's first impression is that he is entering an old quarry. To the left is a perpendicular cliff about fifty feet in height, covered with vegetation, and with large trees interspersed—the presence of these stamping it with a considerable antiquity. A small burn three or four feet in width runs at the bottom. On the right are the quarries, and one's first question might be, Where does the water come from? When the top of the road is reached we come to the muir, which is, with a series of large patches of water and marshy ground, the habitat of

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numerous water-fowl, amongst them at the time of my visit being a solitary swan.

At one time this must have been a large lake, with several islands in its midst, for it is surrounded on all its sides by hills, the enclosed area being from three to four miles in circumference. On the west side stands Kilmalcolm Hydropathic establishment, some 450 feet above sea level, the old lake being probably 50 feet lower. Now the way by which we came through the gully and quarries is nothing less than the outlet of this ancient lake, the barriers of which, having been gradually cut down by the water, has allowed the old lake to drain away to its present level. The little stream above mentioned which comes from it now meanders quietly down through the village of Kilmalcolm, where it is in places covered from sight, and it afterwards joins the water of Gryffe about a mile and a half to the south.

If one of the waterspouts which have been chronicled as occurring pretty frequently of late years should drop its contents within the area of this old basin, the dwellers in Kilmalcolm would get an unpleasant surprise, as there would be no other outlet for the discharge of the water than through the narrow gorge we have ascended. A recent instance of such an occurrence happened in the county of Donegal last summer, when the rush of water through a similar gorge, in which a chapel was built, overwhelmed it, sweeping away and drowning many of the inmates.

I asked a very intelligent-looking old quarryman who was breaking stones for road metal what was his notion about this gully, near which he was working, and how it came to be worn down through the rock with such steep sides. After thinking a little he answered, "Well, I suppose it's just nature." I told him my ideas respecting it, and he said, "Well, I think you will be right, for there is a *dale* of water comes down in the winter time when the snow melts on the hills round about."

The valley to the south, through which the railway runs near the course of the Gryffe, has been subjected to considerable denudation by ice action, and some of the rocks are beautifully marked with striations of several yards in length. These ice markings are, however, only to be seen on bosses of harder material projecting through the melaphyre, which, being soft and easily acted upon by the carbonic acid in the rain water, has been disintegrated so much as to lose all traces of the ice passage. About a mile to the

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west, at the junction of two roads, a hard, close-grained basalt is exposed, and the ice striation, running from north-west to south-east, is very beautifully marked on it.

The bosses of trap above-mentioned vary very much in their composition; one in a field near the road is a porphyritic felstone with large crystals of felspar, very much coloured by the decomposition of the contained iron. An outcrop by the side of the road on the Rowantree hill is a dolerite with a large quantity of magnetic iron. Through the action of the weather on this constituent the exposed parts gradually peel off, so that all sharp angles disappear, and the rock takes on the appearance of a collection of rolled boulders. A good example of similar weathering may be seen on the face of the dolerite cliffs below the western wall of Stirling Castle.

## V.—Note on a Specimen of Altered Dolomitic Limestone from the Cement-stone Series of the Ballagan Group.

By James J. Dobbie, M.A., D.Sc., &c.

[Read 10th February, 1881.]

Last summer Mr. John Young drew my attention to specimens of a peculiar-looking rock found by Mr. Alexander Buchanan at Fintry. The specimens were of a uniform light-chocolate-brown colour and apparently perfectly homogeneous. They were somewhat harder than common limestone, had a waxy lustre, and broke with a sharp-edged splintery fracture, translucent upon the thin edges. With hydrochloric acid they effervesced slowly, at the same time gelatinizing. Externally the specimens were weathered white, and were traversed on the surface by deep fissures coated with a crust of carbonate of lime.

Mr. Young and myself were led at first to believe that the specimens had been found *in situ*. We discovered subsequently, however, that they had been found detached, and not far from the site of an old lime-kiln. On looking to their analysis there is little doubt that they had actually passed through the kiln and had originally come from one of the beds of the Ballagan limestone in the neighbourhood. The difference in composition between the specimens exhibited and specimens of Ballagan limestone analysed



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by Mr. J. W. Young * is just what would be accounted for on this supposition. Although outwardly the specimens appeared homogeneous, analysis showed a considerable variation in composition, but by selecting portions taken from the centre of the mass and as nearly as possible uniform in colour, results which agreed fairly well with one another were obtained.

Dried at 100° C. the specimens lost 8·7 per cent. of water. Analysis of the dried specimens gave the following numbers :—

| | |
|---|---|
| $SiO_2$ (Silica) ... ... ... ... | 18·505 |
| $Fe_2O_3$ (Sesquioxide of iron) ... ... | 2·29 |
| $Al_2O_3$ (Alumina) ... ... ... | 4·63 |
| CaO (Lime) ... ... ... ... | 25·39 |
| MgO (Magnesia) ... ... ... | 23·65 |
| $CO_2$ (Carbonic acid) ... ... | 10·95 |
| $H_2O$ (Water) ... ... ... | 14·10 |
| Total, | 99·515 |

Five different analyses gave results closely agreeing with these numbers.

Analyses of limestone from the Ballagan series (Ballagan Glen) by J. W. Young gave :—

| | |
|---|---|
| Clay and sand, ... ... ... | 11·92 per cent. |
| Silicic acid, ... ... ... | 1·67 „ |
| Lime, ... ... ... ... | 26·99 „ |
| Magnesia, ... ... ... ... | 17·21 „ |
| Protoxide of iron, ... ... | ·64 „ |
| Sesquioxides of iron and alumina, | 2·67 „ |
| Carbonic acid, ... ... ... | 38·0 „ |
| Loss, ... ... ... ... | ·9 „ |
| Total, | 100·0 |

Mr. Young remarks with regard to his analysis that the quantity of $CO_2$ present is less than is required to combine with all the lime and magnesia, and that part of one or other of these constituents must be in combination with silica. It would seem, therefore, that natural causes must have effected a partial alteration of the carbonates into silicates. The same process of alteration has been carried further by the heat of the kiln. On

* Transactions, vol. ii., part 3, p. 211.

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comparing the analysis of the altered specimen with Mr. Young's analysis of the unaltered limestone it will be seen that the principal change consists in hydration of the mineral, and loss of carbonic acid. The hydration must, of course, have been effected subsequently to removal from the kiln. The carbonic acid present is much less than is required for combination with the lime alone. Part, at least, therefore, of the lime and magnesia present must be in combination with silica. As the whole of the water is driven off only at a high temperature, it also must actually be in combination in the rock.

What makes the specimens more than usually interesting is that they correspond closely in composition with certain serpentines of the Laurentian series of Canada, described by Professor Sterry Hunt,* who was of opinion that these serpentines had been derived from siliceous dolomites by metamorphism, an opinion with which Professor Zirkel coincides. † The change which the Ballagan limestone has undergone shows how readily a highly carbonated rock may be converted into a silicated rock. One difficulty in the way is—if serpentine originates thus, what becomes of the lime? A process employed by Mr. Pattison for obtaining carbonate of magnesia from the magnesian limestone of Durham ‡ seems to throw light upon the change which takes place during the conversion of siliceous dolomites into serpentine. On treating the limestone in close iron vessels at a dull red heat, Mr. Pattison found that only the magnesian carbonate was decomposed, the carbonate of lime requiring a higher temperature for decomposition. It is easy to understand that if a rock containing carbonate of lime, carbonate of magnesia, and silica were heated to a temperature sufficient to decompose the carbonate of magnesia but not the carbonate of lime, that the magnesia at the moment of liberation would combine with the silica forming silicate of magnesia, and that the liberated carbonic acid dissolved in water would attack the undecomposed carbonate of lime and dissolve it out. This theory I have not yet had time to verify, but if borne out by experiment it would afford a strong argument in favour of Sterry Hunt's view of the origin of certain serpentines.

* *Phil. Mag.*, 1857, xiv., p. 388. *American Jour. of Science* (2), xxv., 1858, p. 217; and (2) xxvi., 1858, p. 234.

† *Petrographie*, vol. i., p. 332.

‡ Pereira's *Materia Medica*, 1849, vol. i. p. 611.

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I have only to add that the analyses of the altered dolomite were made under my direction with great care and accuracy by Mr. Arthur Wingate and Mr. Robert Thomson of the University Laboratory.

## VI.—Notes on Mull and its Leaf-beds. By W. E. Koch, B.A., F.G.S., F.C.S., &c.

[Read 10th February, 1881.]

The first features of interest which strike the geologist on landing at Salen in the Sound of Mull are the mountains of Ben Greig and Ben More. The north face of Ben Greig, well seen from the north end of Loch Baa, is a fine precipitous cliff and presents a very curious appearance. The rocks composing it are chiefly granite and felsite with felstone dykes, and their peculiarly curved and stratified appearance is caused by contraction on cooling. The base of the mountain is of hornblendic granite, and there are veins and dykes of quartz, pitchstone, and felstone.

Behind Ben Greig towers the glorious peak of Ben More, the mere remnant of a huge volcano which must have far exceeded Etna in bulk and extent. Ben More is very interesting, as here we have the skeleton of a volcano laid bare to its very feet. The lower part is built up of granite and felsite, often very porphyritic, intersected by dykes and veins of felstone and pitchstone; the upper portion is an enormous aggregation of tuffs, ashes and scoriæ, with dykes and lava flows of gabbro, dolerite, and basalt. Here then we have the life history of the volcano plainly shown us, with the two well marked groups of acidic and basic rocks, into which all eruptive rocks naturally fall, clearly separated from each other.

First we have the acidic series, including granite, felsite, phonolite, felstone, pitchstone, and obsidian, distinguished by their paler colours when weathered, greater infusibility owing to their high percentage in silica, and less jointing in columnar forms. These form the foot and earlier eruptive matters of Ben More and extend only a short distance from the volcano. Professor Judd says, "Felstone lavas rarely extend more than ten miles

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from their centres of eruption, while basaltic lavas spread in vast sheets fifty miles from those centres.*

Secondly come the basic series of gabbro, dolerite, basalt, and tachylite, which are distinguished by darker colours, usually dark brown, when weathered, jointed columns—so grandly displayed in Staffa—and far greater fusibility.

After studying rocks in Mull one cannot but be struck by their resemblance to those in Arran, and I feel sure that the old volcanoes of both Mull and Arran belong to the same series of eruptions and were active about the same epoch. This seems to have been during the earlier part of the Tertiary period, probably during Eocene and Miocene times; it must have been later than the Cretaceous, for the erupted matter overlies these Secondary rocks, as may be seen in numerous sections. When the volcanoes first broke out, probably land extended westwards as far as the hundred-fathom line, and the island of St. Kilda is a remnant of that old coast. Staffa and the isles to the west are mere fragments of the old lavas that once covered this land, and if you refer to the Admiralty charts you will see how a slight rise of about four hundred feet would almost restore the old condition of affairs. The first eruptions were acidic and did not extend far, but the second series of basaltic lavas extended immense distances, and to them we owe the preservation of the famous Ardtun leaf-beds, so well described by the Duke of Argyll,† and which were now the goal of my journey.

As I passed along the shores of Loch Screidan, the step-like character of the hills (whence the old term of "trap" rock) clearly proved the volcanic origin of the country.

Bunessan is capital headquarters. Ardtun Head lies some half an hour's walk over a breezy moor towards the west; Craig-y-chroman, of tourmaline renown, is hard by on the shores of Loch Assapoll; Staffa, Iona, Gribun's cliffs and caves, Carsaig, and numerous other points of geological and romantic interest, are within easy reach; in short, it is a geological paradise. I spent a week examining the Ardtun beds, which are easily accessible but difficult to work, unless one was allowed to mine them systematically; a small level driven along the main leaf-bed would not cost much, and would secure a rich harvest.

*Judd, *Quart. Jour. Geol. Soc.*, Aug. 1874.

†*Quart. Jour. Geol. Soc.*, vol. vii.

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The generalized section is as follows in descending order—

1. Columnar basalt. 40 feet. Two or more flows separated by glassy basalt or *tachylite*, not obsidian as stated by the Duke of Argyll, for obsidian belongs to the trachytic or acidic series. This tachylite is formed by a fresh flow fusing the surface of an older lava stream.
2. Thin leaf bed of ash-shale. 2 feet.
3. Coarse tuff, about 15 feet, which resembles modern volcanic ash or tuff beds, and contains highly-altered flints.
4. Main leaf bed, hard above, soft and friable below. 2½ feet.
5. Tuff bed, ashes, scoriæ, etc. 6 feet.
6. Baked mud with leaves. 18 inches.
7. Vesicular basalt, with zeolites passing into columnar basalt.

After a general exploration, I settled down to work systematically at the middle leaf-bed on the north-east side of a glen leading down to the sea, and most of the leaves shown in dark matrix came from this spot. They appear to belong to species such as *Rhamnus, Berchemia, Quercus, Corylus, Cornus, Ulmus, Carpinus, Fagus, Platanus, Myrica, Betula, Alnus, Salix, Populus*—in short, just our ordinary forest trees, while conifers are probably represented by *Pinites, Taxodium, Sequoia*, and *Glyptostrobus*. A leaf resembling Ivy is present. Ferns and Equiseta abound in certain layers—the Proteaceæ are represented by *Hakea*, which is tolerably common in places, and there is a leaf resembling *Cinnamomum*. There are also traces of Mosses. These plant remains are now in the Hunterian Museum of the University of Glasgow, and I hope some botanist will be kind enough to correct my blunders and name them rightly.

The section where I worked most is as follows in descending order :—

1. Columnar basalt.
2. First leaf bed.
3. Ash bed with flints. 17 feet.
4. Blue-grey shaly ash-bed with large leaves of Plane, Sequoia, Ferns, Equiseta and Mosses. 12 inches.
5. Brown and blue shales with Ferns and *Rhamnus* (Buckthorn). 20 inches.
6. *Rhamnites* or Buckthorn bed, almost made up of leaves and twigs of a *Rhamnus*. 2 to 6 inches.
7. *Infra-Rhamnites* bed, a mass of leaves and twigs resembling those above, but with entire margins. 2 to 6 inches.

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8. Brown soil with roots and branches, one of which measured 5 inches across and another 2 inches across, and half an inch thick. This bed rests on eruptive matter, and here, I believe, we are on the site of the old forest, but more careful and systematic search is required than the time at my disposal enabled me to give.

The Duke of Argyll, in his paper above quoted,* says, "Two other remarkable circumstances remain to be noticed; first, that no trunks of trees, no branches, nothing beyond the size of the merest twig, has yet been found associated with the leaves;" and he then gives his idea of the life-history of these beds, and supposes them to have been deposited in a shallow marshy lake. I think he is only partly right in this theory, and prefer to read my section as follows:—

First, by weathering, a slight soil formed on the erupted matter, and there shrubby vegetation first began—this is the early history of all forests. These shrubs decayed and formed more mould, on which grew Buckthorns (*Rhamnites*) and perhaps small trees; in this way beds Nos. 6, 7, and 8 of my second section were formed. As time went on the decaying vegetation held moisture sufficient for Ferns to flourish, and larger trees sent their roots into the lower beds; bed No. 5, containing a thickness of 20 inches of remains, shows the length of this period. As the soil thickened forest trees could grow; and so in bed No. 4 we find Planes, Conifers, and other forest trees. These would, as we know, dam back streams in places and form marshes wherein Equiseta might flourish, and as the parts of the leaf-beds explored are so very few, and small in area, I think it is somewhat premature to conclude that we are not on the site of the old forest, especially as roots or branches—but more probably roots from their position—have been seen and found *in situ* in bed No. 8 of my second section. It is remarkable that Equiseta seemed only to occur in No. 4 bed. Finally, the forest was overwhelmed either by ashes or mud streams, and the preservation of the remains is due to the fact of the basalt covering being strong and thick enough to resist denudation, and especially glaciation, for the fjords of the west coast are a lasting record of the size and strength of the old ice ploughs.

I took the trouble to carefully split and count one-half inch of

* *Quart. Jour. Geol. Soc.*, vol. vii., p. 96.

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matted leaves from bed No. 5 of my second section, and I found sixteen layers—from this one might argue that it took sixteen years to form, and hence 6 inches might have taken about a century. I do not know how this compares with other calculations, but I mention it as a note by the way.

I will now briefly allude to the Tourmalines at Craig-y-chroman, the collection I made being now also in the Hunterian Museum. They occur in a vein in a small boss of schist on the south shore, near the west end of Loch Assapoll. The vein is opened on the north face of the boss and is about 100 feet or so above the loch. The vein stuff is white Felspar and black Mica, and a good pick-axe, hammer, and stout chisel or gad, are very handy. The Tourmalines are black, double-ended, and are often very perfect crystals. Some are fairly large and most show the forms 100, 110 and 111 of Miller's system. A man called Campbell who lives at Bunessan was my *fidus Achates* and guide on these expeditions, and I found him very useful.

In conclusion, I must express my acknowledgments to the very excellent papers by the Duke of Argyll and Professor Judd to which I have previously referred. Without their good company I should have misunderstood or passed over much that I saw in the most interesting and beautiful island of Mull, to whose shores I hope it may some day be my fortune to return.

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## VII.—The Silurian Rocks of Logan Water, Lesmahagow.

By J. R. S. Hunter, LL.D., D.Sc., F.R.Ph.S.Ed., Hon. Mem.

[Read 10th March, 1881.]

Having been requested to show the members of our society some of the fossil crustaceans which I found whilst working among the Silurian rocks of Logan Water, and to make a few remarks upon them, it may not be out of place to preface the subject by a few introductory remarks to those who may be unacquainted with the classic ground, to geologists, of the Lesmahagow district.

The parish of Lesmahagow is a very important one as regards its geology, its palæontology, and its archæology. It contains about 65 square miles according to the Ordnance Survey. On the Douglas, Muirkirk, and Strathavon borders the hills are of con-

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siderable height—Nutberry, 1712 feet, on the south-west, the source of the Nethan Water; Priesthill, 1655 feet, on the Ayrshire march; Mickle Auchensilloch, 1609 feet, and Little Auchensilloch, 1479 feet, on the Douglas border; Auchengilloch, 1514 feet, east of Strathavon and at the head of the Kype Water; Auchrobert Snout, 1193 feet; Dunside Rigg, 1308 feet, and one of the sources of the Logan Water; the Law, 1376 feet, near the head waters of the Poneil Water; Dillerhill, 1017 feet; and a lower range of heights upwards from the Clyde to the watershed of Nethan Water. The parish is chiefly drained by the Nethan Water, which from Nutberry Hill to the Clyde has a course northeastward of about 13 miles, including its windings. The Logan Water is next in importance, but is scarcely half the length of the former stream, into which it flows near Stockbriggs. The Kype Water is of considerable size, dividing the parish in the west, and joining the Avon near the town of Strathavon. Besides these larger streams there are numerous burns, as might naturally be expected in a district so hilly, and having so much moss and meadow land.

I know of no locality where a more interesting and instructive geological field presents itself than here. Within a short distance we can trace the strata from the lower members of the Coal Measures down to the various beds of the Upper and Lower Carboniferous limestone series. The Old Red Sandstone and the Upper Silurian strata can be seen exposed in the banks of the Nethan Water and those of its lateral tributaries. Within a short distance of Craignethan Castle (where I had the pleasure of reading a paper to the society some years ago on the occasion of one of its Queen's Birthday excursions), which has been immortalised by Sir Walter Scott under the name of Tillietudlem Castle in his story of "Old Mortality," we find, at Fence Pit, a most extraordinary and interesting section, embracing strata of the Upper Coal measures, whilst in adjoining glens are to be seen the Lower Limestones, Lower Coal Measures, and Old Red Sandstone. In the parish of Lesmahagow, as well as in Carluke parish, those interesting beds of argillaceous shale and fresh-water limestone deposits, known as the Ballagan series, are awanting. The Calciferous Sandstones are, however, more or less exposed in the neighbourhood of Stockbriggs House, and continue until we reach the junction of the small stream known as Scotsburn on the

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Nethan Water, where the upper members of the Old Red Sandstone are exposed, and are found to consist of concretionary limestone embedded in a red marl. This limestone has been long searched for organic remains, but until recently no traces of such have ever been discovered. These beds were probably deposited in an inland lake supercharged with carbonate of lime, and no doubt similar to the modern Salt Lake of Utah, in America.

The Old Red Sandstone is extremely well developed in the parish. Its base passes down conformably into the Upper Silurian strata, and is seen along both of its anticlinal folds, where they begin to join each other. The lithological character of the strata is very variable, consisting mostly of chocolate and grey sandstones, with grey and green flaggy shales, while the uppermost beds of the group are not here developed. The thickness of the strata, from the quartz rock conglomerate upwards, may be not less than 10,000 feet. These conglomerates are seen in Nethan Water, Eaglin Burn, and at various other places. Starting from near Deadwater Bridge, on the Strathavon Road, then in a straight line passing onwards through High Kypeside, Priorhill, and Auchrobert Snout, to the Nethan Water, near the junction of the Eaglin Burn, this track will easily represent the course of the conglomerates separating the Old Red from the red and grey shales. A line drawn from Deadwater, Bellscroft, Dunduff, Ladehead, and onward to Nethan Water, below Kerse House, then going by Auchnotioch and Hallhill to the islands in the Clyde at Underbank, above the village of Crossford; then up the Clyde past Hazelbank, Stonebyres, Cora Linn, and Bonnington Falls, by Harperfield to Douglas mouth, going nearly west by Cora-more and Birkhill to Moat near Bankfoot; then by Auchtool, Devonburn, and Aulton to Nethan Water, between Bracken and Brownhill; then by Fulford, Meadow, Craighead, and Bankend, will form nearly the boundary enclosing the Old Red Sandstone, and dividing the Coalburn and Auchenheath coalfields. Although there is such a stretch of the Old Red series, it has as yet proved almost devoid of organic remains, but I am not without hope that a locality may yet be discovered where lie some of those wonderful organisms so ably and graphically described by the late Hugh Miller.

Igneous rocks occur frequently in the parish, causing numerous faults and dislocations, some being of great extent. One dyke, traceable from Douglas through the Hagshaw Hills, sends off

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branches in a south-west direction by Craigenrigg, passes through Lawhill, crosses Nethan Water, up the side of and over Nutberry Hill, crosses Logan Water, runs along part of Goodbush Hill, is magnificently exposed at Auchengilloch, and then runs past Hartenrigg, Sidehill, Laigh Drumclog and High Drumclog, whence it branches into Ayrshire. Between Dunside and Shank Castle, on Logan Water, dykes are observed, varying from a few inches up to many feet in thickness, and between Dunside and Auchrobert farmhouse numerous dislocations of the stratified rocks are observed. In the immediate neighbourhood of Lochfennoch, near Dunside, there is an interesting dislocation in the strata, exhibiting a fault which, so far as has yet been ascertained, is from 60 to 70 feet deep. On the one side of the fault the Silurian rocks are shattered into splintery fragments, intermixed with other detrital matter, while on the other side of the fault they remain as a hard, compact, arenaceous deposit, which has yielded, up to the present, no organic remains. To the east of the fault there are numerous dislocations, presenting fine examples of dolerite and intrusive felstone. On Hillcross Knowe, Auchrobert Hill, which is composed of red porphyry, there are two bosses, or pot-holes, of igneous rock, 50 yards separate from each other. One is 12 feet in diameter, the other 6 feet; and they still retain their depressed or cup-like aspect. Under more careful investigation they may prove to be the focal vents of these igneous rocks, while the dykes and dislocations are filled up fissures produced by the volcanic ejection, and the great fault above spoken of may have been produced by the same agency.

In the district of Lesmahagow no traces of the Lower Silurian rocks are observed, but we have magnificent sections showing the gradual and conformable passage of the Upper Silurian series into the basement beds of the Old Red Sandstone. The Upper Silurian rocks are widely distributed throughout the world, being found in various parts of Great Britain, Italy, France, Spain, Germany, Russia, and other countries of Europe, also in America, Asia, Africa, and Australia; but they have been nowhere distinctly seen in true stratigraphical relationship with the lower members. In Ayrshire we observe the uppermost members of the Lower Silurian, but the succession ceases just where we should expect to have seen the rocks of the upper strata developed. The Upper Silurian rocks are found in Lesmahagow, in the Pentlands,

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and along the coast of Kirkcudbright. In the two former localities they lie on the northern side of the Lower Silurian belt of the southern uplands, while the latter shows the upper and lower series in close proximity; but here again we have conglomerates, possibly indicating a break between the Upper and Lower members of the Silurian strata. The rocks are twisted, and masses of porphyry and other crystalline rocks make their appearance. At the surface the Upper Silurians of the Pentland Hills are separated from the Lower Silurians by intervening conglomerates of the Old Red Sandstone period, whilst in Lesmahagow the relations of the two series are entirely concealed.

The vicinity of Logan Water was the retreat for many of our brave Covenanting forefathers after the battles of Bothwell Brig, Drumclog, Philipshaugh, &c., and has therefore justly earned a historical place in the annals of our country. It has also in our day found an extended fame in the scientific world as containing the rocks where lie entombed the wonderful crustacean forms first discovered by Dr. Slimon, of Lesmahagow, with which his name will ever be associated in the records of British palæontology. The order *Merostomata*, to which they belong, has been most ably described and illustrated by Dr. Henry Woodward, of the British Museum, and we find in it materials for comparison with recent forms of crustacean life which are wanting in other groups—namely, the larval stages of the highest recent forms, these old organisms being possibly the forerunners of the air-breathing Arachnidæ. One most interesting feature which they possess is the bipartite division into brachyuran and macruran forms, exemplifying the crawling and swimming types—in the one by the body segments, as displayed in *Limulus*, in the other by the somites of *Pterygotus*, thus showing that life in all its forms did not exist at that remote period. On the contrary, there seemingly were successive steps in the work of creation, and the organisms existing at one period, after serving the ends for which they were created, passed gradually away to make room for new types, which in their turn also became extinct.

Suppose we start on Logan Water, at the point where the Old Red Sandstone conglomerates terminate, where we have a most magnificent view of hill and dale, and trace the rocks up the stream, we observe that they form a descending series of strata, often disturbed by igneous action, which has contorted them and

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elevated them in various directions, and these conditions continue at short intervals till near the foot of Lochfennoch, not far from Dunside. In that neighbourhood there is an interesting dyke of melaphyre, which, although ejected through the Silurian deposits, in no way affects the crystalline condition of the beds on either side so far as observed.

The Upper Silurian strata occupy an estimated area of about 10 square miles, and are arranged in descending sequence. They consist, in the upper portion, of the following zones, viz., green arenaceous flaggy bands, with partings of grey and red argillaceous hard shales, upwards of 100 feet thick; then a series of dark-grey, green, and chocolate-coloured argillaceous hard shales about 200 feet thick. Below these we have strata, about 400 feet thick, consisting of hard dark-grey shales, with bands of calcareous nodules, and this horizon contains the *Pterygoti* and other crustaceans in their best developed conditions. Below this again we have grey and olive-coloured flagstones, with hard bands of greywacke, sibly 300 feet thick; and following these in descending there are dark-grey and olive shales, exceedingly hard tow base, and about 300 feet thick. Last of all, we hav of greywacke with their partings; these forming portion of the Upper Silurian Rocks, being, perhaps of 2,000 feet thick. Having carefully examined the entire ra of the Logan Water, up to its source in the eastern slopes of the Nutberry Hill, I can state, with some degree of authority, that only in certain horizons are any traces of organic remains to be observed. On Dunside Burn, which joins the Logan Water, I made considerable explorations, and was rewarded by finding remains of *Pterygotus bilobus (or P. inornatus), P. accidens, P. anglicus, Slimonia acuminata*, and other forms which I have not yet identified with any degree of certainty. From the size of the heads, with their telsons, in some of the specimens, although fragmentary, I am led to believe that only the larger forms of these crustaceans had frequented this area of the inland sea. Underlying these strata we found a bed with *Lingula* in an excellent state of preservation, indicating that this part of the old Silurian sea was more or less brackish, and that while this sheet of water was being separated by lacustrine conditions, the *Lingula* still found a sufficient amount of saline matter in the water to sustain life. It also indicates that there were, during this remote period, frequent

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oscillations of the earth's crust, the portion covered at one time by salt water, and at another by fresh water, or being probably for a time dry land. Immediately underlying the *Lingula* bed is a series of thin flags, in which were found the remains of *Pterygoti*, but all in a fragmentary condition; and the beds that in their turn underlie these were, for some considerable depth, absolutely destitute of organic remains, so far as observed in our explorations. About 100 yards further up the Logan Water there is another series of deposits, consisting of thin grey slabs, upon which were found many examples of *Pterygotus bilobus* and *P. perornatus*. A number of these were perfect in outline and in most excellent preservation, while associated with them were several granular masses which, on further investigation, may probably turn out to be the ova of these crustaceans. These beds are the superior members of the Upper Silurian deposits in this district.

The next locality where I made explorations was on both ...les of the small dyke formerly alluded to, above Dunside, on ... Water. There we found numerous remains of *Pterygotus* ..., *P. accidens*, *P. perornatus*, *Slimonia acuminata*, *Stylon-* ... *Eurypterus obesus*, *Ceratiocaris papilio*, *Beyrichia* ... forms as yet undescribed, all being more or less ... preservation. Going up the stream to Shank Castle ...e is a descending series of strata, dipping north-east, at angles varying from 20 deg. to 25 deg., and the rocks are greatly disturbed and twisted by porphyritic dykes. In the immediate neighbourhood of the Castle we found a bed containing examples of *Eurypterus obesus* and *Pterygotus inornatus*, some specimens being in excellent preservation. At the same place may be seen a great anticlinal axis, running nearly east and west, the strata being raised up in the centre like the ridge of a house, and being greatly disturbed by volcanic action. From Shank Castle to above Logan House the upper members of the Silurian rocks are seen, but the lower members are also to be found as the thick, hard, flinty beds of Nethan Water make their appearance, and give us unmistakeable evidences that a great dislocation of the strata has here taken place, the rocks being twisted and broken, and the lower strata raised to the position of the higher beds. A few hundred yards beyond Logan House occurs a hard and argillaceous rock, containing a large proportion of arenaceous materials.

Underlying these deposits lie a series of argillaceous beds, in

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which we find sun cracks, ripple marks, and markings which seem to be the tracks of crustaceans, all giving evidence of shallow-water conditions, with periodical deposits from running water charged with mud. These beds consist of thin flags, which speak of frequent alternate conditions of subaërial and subaqueous exposure, extending over a long period of time. Intermixed with these flags are found a great number of hard beds, many of which I have broken up, but without, as yet, finding any trace of organic remains. Beneath these is exposed a series of beds in which are found a large number of phyllopod crustaceans, with here and there a few gasteropod shells. The forms found were so numerous, and their surroundings so suggestive, that I dare hardly venture to offer an opinion. If, however, I may be permitted to hazard a remark, I would say that their abundance seems to point out that the deposits here exposed were banks lying under the influence of running water, where these crustacean forms found abundance of food. This opinion is strengthened by the fact that within a few feet of them we lose all traces of organic life. Underlying these beds there is a series of soft argillaceous deposits a foot in thickness, in which lie a great number of balls from one to four inches long. When split they are found to contain the remains of phyllopod crustaceans in a beautiful state of preservation, and the discovery of which induced me to continue my researches on the spot in the hope of finding other forms. But poor results, however, followed. We quarried for two days, only finding four balls, though one of them contained the largest and one of the best preserved crustaceans I had yet discovered. There were thus fresh indications of a change in the conditions of the bank upon which these forms had lived—and one opposed to their continued existence—whether from the influx of matter detrimental to them, or from changes in the bathymetrical surroundings brought about by the alternation of these deposits by currents, or from the elevation of the inland sea or lake, cannot be as yet stated. Such changes are to be seen in recent days, and I do not overstep the bounds of prudent speculation in supposing similar conditions to have prevailed in this remote period of the Upper Silurian epoch.

Having lost all trace of recognizable fossils in these beds, we tried the banks of the Kip Burn, and were partially successful, finding several specimens of *Pterygotus bilobus*, which, although

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few in number, were sufficient to prove continued organic existence.

A record of the fossil remains I have found in the various positions pointed out may help at some future time to assist in arranging these beds chronologically, and thus correlating them with other strata, probably with the Upper Ludlow rocks of England; but the organisms I have obtained are not exactly similar to those found elsewhere in this stage, but possibly further search may afford more conclusive proofs towards a connection between these and other distant horizons. In the meantime my object has been to note the discovery of these interesting forms of ancient Silurian life in the beds I have investigated. At a later date I hope to be able, through further research, not only to record other facts, but to present the results of my work in a more extended and better developed form. Such investigations and such explorations may at least help to assist in clearing up some doubtful points in the palæontological history and arrangement of this most interesting sub-division of the Silurian rocks of Scotland.

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## ...RIPTION OF AN ERRATIC BOULDER ON THE HIGHLAND ...AILWAY. BY E. A. WÜNSCH, F.G.S., Hon. Associate.

[Read 14th April, 1881.]

A CONSIDERABLE number of years ago, when our Society was young, and the story of glacial phenomena was foremost in our minds, my attention was attracted by a large boulder conspicuously exposed near the embankment of the Highland Railway, about 500 yards south of the Dalwhinnie station, on the Loch Ericht side, or the left side going north. So far as could be observed from the railway, the dark rounded mass of the boulder was intersected by several considerable veins of granite, which gave it a reticulated appearance so striking that even a non-geological friend to whom I mentioned the subject was enabled to identify it at once when passing in the train. In the course of years I had passed and repassed it probably a dozen times without ever being able to break my journey for closer inspection. I was glad, therefore, when a prolonged stay in the neighbourhood of Blair Athole last summer afforded me the long-looked-for opportunity of proceeding

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to Dalwhinnie station, and spending an afternoon in examining the boulder and its surroundings.

I found it was lying on a level gravel bed close to the railway fence, having been apparently uncovered by the removal of the superincumbent gravel for railway purposes. Its longer axis pointed NNE. by SSW., and its measurements were—in length, 7 ft. 9 in.; in breadth, 5 ft.; and in depth, 4 ft. The schistose rock forming the bulk of the mass was of a dark-slate colour, very compact, in some parts granulated, and interspersed with small flakes of mica, showing lines of stratification at an angle of about 20 deg. Smaller veins or beddings of quartz and mica, $\frac{1}{4}$ to $\frac{1}{2}$-inch in thickness, ran along the planes of stratification, and were intersected in the most capricious manner by larger and more granitic veins, varying from 2 to 8 inches in thickness. The largest vein on the west side of the boulder was intersected by a 4-inch vein at the distance of about a foot, before both veins terminated in a solid granitic mass, forming the north end of the boulder.

When I first noticed the boulder from the railway carr[illegible] about fifteen years ago, it appeared to me one solid unbrok[illegible] of rock, but on closer examination, two considerabl[illegible] forming one-tenth or one-eighth of the mass, ar[illegible] fractures, as if broken off during the uncovering pr[illegible] haps by some too inquisitive geologist, were found lying at a dista[illegible] of about four feet from the parent rock. Although this spoils the symmetry of the boulder, it has the advantage of exposing a considerable portion of the inner structure, which shows that the larger veins above referred to bifurcate again at the south end in dimensions similar to those described. One of them shows an actual elbow, with delicate threads running off into the planes of stratification, and the veins throughout the mass are so delicately shaded off and distributed that it is impossible to entertain the idea of the injection of any molten or pasty mass into the fractured slate rock, some of the veins terminating in the finest threads, which can only have been chemically formed within the schistose matrix.

I purpose confining myself strictly to the description of the Loch Ericht boulder; but I may mention, in conclusion, that in the very gravel-pit in which it is situated, and in the gravels and boulders of the adjoining River Spey, numerous specimens of so-called junctions of granite and slate are to be seen. The west side of Dal-



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whinnie station itself is simply an excavation into a boss of slate rock, showing a vein of red granite running through it. Other similar veins on a larger scale can be seen in the hillsides along the railway south of the station, but all of a character making it impossible to believe in the eruptive character of granite as held in popular text-books. Since I read my paper on the non-eruptive character of the Arran granites, at the Glasgow meeting of the British Association in 1876, I have continually followed up the subject, and have gathered large materials for it again recently, during a stay of several months in Devonshire and Cornwall; but the subject grows upon the investigator, and involves so many collateral questions that I can scarcely foresee the time when I may hope to be able to offer the Society a paper discussing the subject at full length.

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## Sketch of the Geology of Part of the Mainland, Shetland. By Thomas Stewart.

[Read 5th May, 1881.]

Scotland affords several well-known localities for studying the mineral composition, order of deposition, and disturbance of the strata belonging to the older systems, but none of these exceed Shetland in interest. Here within a very limited area may be seen all the members of the metamorphic series; and flags, sandstones, conglomerates and breccias belonging to the Old Red Sandstone system, while the same variety of minerals is not to be found in any county in Scotland. Contemporaneous and intrusive igneous rocks are well represented, and their relations to the sedimentary strata are usually well seen either on the shores or in the bare rocky faces of the cliffs.

These islands have received considerable attention from geologists. In 1822 Dr. Hibbert published his "Description of the Shetland Islands," a work abounding in geological research. Since then various papers have been published on the mineralogy and the geology of the islands, notably by Professor Heddle,*

* *Mineralogical Mag.*, vol. ii.

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and by Messrs. Peach and Horne* of the Scottish Geological Survey. Induced by the study of these writings I spent a few holidays last summer geologising in the northern part of the Mainland, and now venture to give a few remarks on that district, as the land phenomena are considerably different from what we are accustomed to meet with in the West of Scotland.

The town of Lerwick is built upon rocks of Old Red Sandstone age, which are well exposed on the shores to the east and west of the town. At these places the rock is a very coarse-grained sandstone, composed of grains of felspar, quartz, and mica; occasionally there are thin intercalations of grey and red shales, while at other places the rock passes into a coarse conglomerate made up of pieces of granitic rocks, cemented by small grains of the same—the whole series evidently having been derived from the wearing down of granitic rocks. By passing northwards along the shore to the low projection of Rovey Head, the Lerwick series is seen to pass down through a few beds of flags into coarse conglomerate which is thrown down against the schists by a fault which trends south-westward across t[illegible]. There are no high cliffs between Rovey Head and L[illegible] this may be explained by the fact that the strat[illegible] sea. To the south-west of Lerwick the sandst[illegible] bluff cliffs with, here and there, a tall isolated stack stan[illegible] in the sea. Some of the cliffs near Fladabister exceed 200 feet in height. Near this locality a coarse breccia may be seen resting unconformably on tilted-up beds of mica-schist, and largely made up of angular fragments of the underlying rock. The breccia appears to be more the result of the action of ice than that of water. Messrs. Peach and Horne in their paper state that, on account of faulting, the higher strata are brought into contact with the schists and basement breccia, except near East Quarff, Fladabister, and at Loch Spiggie in Dunrossness. From their traverses they conclude that the strata occur in the following ascending order:—1. Basement breccia; 2. Brenista flags; 3. Rovey Head conglomerates; 4. Lerwick sandstones; 5. Flaggy series of Bressay; but with the last we are not concerned at present.

By following the road which leads to Northmavine, the metamorphic schists are met with between the second and third

* *Quart. Jour. Geol. Soc.*, vol. xxxv., p. 778.

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milestones, and further on, by the side of the new road, and in a gully where the new and old roads diverge, sections of clay and chloritic schists are well exposed. The strata are highly inclined and the strike seems to be about 20° to E. of N. On crossing the valley at Deals Voe the road leads north-eastward to Laxfirth Voe. At this place a narrow band of hornblendic schist crops out, which is succeeded by a band of limestone well seen where the bridge spans the head of the voe. The bands run in a NE. and SW. direction, and coincide with the bottom of the hollow which extends south-westward among the hills.

The two hills—Wart of Laxfirth and Wadbister Hill—to the north of Laxfirth Voe are composed of coarse-grained mica-schist and gneiss. At Wadbister Voe another band of limestone crops out. Its strike is a little to the east of north. North and west of this the rocks are all of a micaceous or gneissose character, with a few bands of quartzite. Inland the strata, in most places, are concealed by a deep covering of peat, but in the streams which into the voes, or on the bare sea beaches, the different ical characters of the strata are well seen.

turesque village of Olnafirth, at the top of Olna Firth, limestone is seen cropping out between two bands schist. The strike, as in the other instances, with the axis of a longitudinal valley, and its track may be followed by the patches and streaks of green turf which here and there accompany it.

Messrs. Peach and Horne are of opinion that the coincidence of the strike of the limestone with the axis of a valley may be partly due to the action of carbonated waters dissolving the limestone.

Taking the road which branches to the right at Olnafirth, a few miles brings to sight a mass of granite. Where it comes in contact with the metamorphic rock the junction is sharply defined, proving that it is intrusive. To the west, on the opposite side of Sulem Voe, a granite of similar appearance is seen, and at the head of the voe a dyke of the same crosses to Busta Voe, so that there can be little doubt that the two masses unite under Sulem Voe and form its bed.

The high ridge at Mavis Grind is composed of diorite, the same rock extending northward to Rona's Voe and separated from the granite at Sulem Voe by a wedge of metamorphic rocks, which as

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it extends northward to Ollabery loses its wedge-like shape and runs in a sinuous form to Fethaland, the northern extremity of Northmavine.

The diorite sends numerous dykes and veins into the metamorphic rocks; besides these there are other dykes and veins of felsitic granite which traverse the diorite and metamorphic schists alike, proving that, while the diorite is newer than the schists, the felsitic granite is newer than the diorite.

A narrow band of metamorphic schists forms the north-west boundary of the diorite. It extends from Rona's Voe to Hillswick Ness, becoming a true clay slate near the extremity of the latter. Like the metamorphic rocks to the east, it is also traversed by veins and dykes of granite or quartz-felsite which have produced numerous accidental minerals near the point of contact. Professor Heddle, who has thoroughly investigated the mineralogy of these isles, gives the following list of minerals as being found at Hillswick Ness:—Radiated Hornblende, Pink Albite, Actinolite, Anthophyllite, Precious Serpentine, Purple Quartz, Ri[illegible] dolite coating Magnetite, Kyanite, Margarodite, Chlorite, and [illegible] Low, in his "Tour through Orkney and Shetland" in 17[illegible] the following curious description of some miner[illegible] shown at this place:—"Near Hillswick was sh[illegible] a large vein of fattish kind of stone called here Claber, use[illegible] cases as a medicine, especially in excoriations of children, the small-pox, &c. At some distance this is found in vast quantities, the whole sea-beach consisting either of this or a green flinty-like matter composed of long fibres and almost transparent. The fat stone is white, mixed with purplish spots of various tints, and in some places almost white. Where it is exposed to the air it is pretty hard, yet may be easily cut with a knife; after digging a little deeper it becomes softer, yet the softest parts never stain the fingers but feel clammy as if rubbed with oil or grease. What other properties this fossil may have time will try, but one it seems to possess equally with Fuller's earth, to which it is near akin, that is, taking greasy spots from woollen clothes, which it does equally well with the former. The green rock may be raised in pretty large pieces, seems to approach the nature of Amianthus; the Claber in pieces of any size."

Rona's Hill and the district to the north and east of it are composed of granite and quartz-felsite. These cross Rona's Voe and

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form about half the area west of the Hillswick schists. West of the granite south of Rona's Voe a series of tuffs and slaggy porphyrites occurs interbedded with numerous beds of fine grained sandstones and shales which have been proved to be of old Red Sandstone age. The strata are well seen in the cliffs at Ockren Head and southward by the Grind of the Navir to Stennis. The whole series reminds me very much of the basement rocks of the Old Red, as seen in the east of Scotland.

Dykes and veins of quartz-felsite traverse the porphyrites and occasionally cut across the lines of bedding, so that the mass of this rock in Rona's Hill appears to be of later age than the porphyrites. A still later intrusion of igneous rocks has taken place, as dykes and veins of a basic rock traverse the quartz-felsite and porphyrites. In some of the cliffs of Rona's Hill these stand out in wall-like masses, while at other points they have decomposed quicker than the surrounding rocks, thereby allowing the sea to hollow out caves and geos. As seen by the specimen, the granite is coarsely ystalline. We are accustomed to ascribe this structure to the of great pressure on the molten mass as it slowly cooled in the earth's crust. Assuming that the granite and quartz- thmavine were formed in this way (and there is no ~~not~~) there must have been an immense overlying ...ks of which not a vestige now remains. In Papa Stour, Professor Geikie has detected a remnant of Old Red Sandstone overlying the quartz-felsite, while in other places which Messrs. Peach and Horne have visited, they have seen phenomena which, they consider, justify the conclusion that the granite of Rona's Hill plateau "is a great intrusive sheet which forced its way upwards and laterally between the metamorphic strata on the one hand and the members of the Old Red Sandstone on the other, at a time when the Mainland lay buried under the sedimentary deposits which accumulated during that period."

Throughout the whole of the northern part of the Mainland faults are common, but except on the sea-beach and in the cliffs they are hidden by a thick covering of peat. On the south bank of Rona's Voe a fault brings the porphyrites and quartz-felsite together. At the Heads of Grocken another brings the quartz-felsite into conjunction with the schists. Southward on the east and west shores of the Mainland faults and dislocations abound; along the line of some, the sea has hollowed out some of the most

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picturesque caves and geos imaginable. Except at Fladabister the boundary between the Old Red Sandstone and the schists is formed by faults, and throughout the sandstone itself small ones occur—four or five of these being seen on the shore between Lerwick and Rovey Head.

Ice has played a great part in giving the present outline to the hills and valleys of Shetland. The rounded and flowing forms of the hills, the *roches moutonnées*, the Boulder-clay, the erratics, and above all the striæ, all testify to the presence of ice in former times. To take a few instances in proof of this; in the valley which runs north from the head of Olna Firth, great boulders of gneiss and mica-schist lie in all directions, the hill to the west is rounded and planed off into flowing lines, while the steep hill which rises from the southside of the voe, being exceedingly bare, shows mammillated surfaces of rock peeping through the scanty covering, and looking as if the ice had only lately taken its farewell.

Northwards by the side of the road, near Busta Voe, there is another accumulation of boulders; and still further north, betwe[illegible] Mavis Grind and Pondswater Loch, striæ may be observed a[illegible] the rocks where they show through the heather: those [illegible] noticed had a bearing of a few degrees south of w[illegible] at the mouth of Rona's Voe, the bearing varies [illegible] west of north. Striæ are plentiful in this locality, [illegible] are somewhat confused it is not an easy matter to determine the reliable ones. The bearings which I have given appear, however, to be the most reliable.

The deposits of Boulder-clay show, when seen in section, that the lower part partakes of the nature of the rocks on which it lies, and is largely made up of fragments of the same; while further up in the section the boulders and striated stones show that they have been carried from areas which lay in the track of the ice-sheet. This is well seen in a section west of Hillswick, where the Boulder-clay rests on a micaceous gneiss, and its lower part partakes of the composition and colour of this rock, and contains sub-angular fragments of it; higher in the section the boulders of gneiss are almost wanting, their place being taken by pieces of diorite, with occasional pieces of quartz-felsite derived from the dykes which lay in the path of the ice. The diorite lies *in situ* only to the east and south-east of Hillswick Firth, while the porphyrites lie to the west of this locality, and as the diorite stones are very abundant in

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the foregoing section, and porphyritic stones entirely absent, there cannot be the least doubt about the direction from which the ice came.

Again, boulders of diorite are seen reposing on gneissose rocks on the west side of Hillswick Firth, while the diorite area is on the opposite side of the Firth, so that these boulders were probably carried to their present position by ice.

Some small sections of Boulder-clay are seen among the porphyrites west of the section referred to at Hillswick. Pieces of lava and tuff now make their appearance, and the diorites diminish in number as their source is left.

Being more intent on mineralogical pursuits than on finding traces of glaciers, I did not visit any sections of Boulder-clay except those which lay in my path, so that my facts are not sufficient to permit of speculation as to the direction of the ice-flow. Happily, Messrs. Peach and Horne have made an extensive survey of the Shetland Isles for the purpose of settling this point, and they are of opinion that Shetland must have been glaciated by Scandinavian ice which flowed in a westerly direction, but on coming in contact with Shetland was deflected in a south-westerly direction [illegible]ot over the high grounds, when it turned to the north-[illegible] the latter movement being probably due to the sheet [illegible]posed by a similar sheet flowing off the hills of

Messrs. Peach and Horne are also of opinion that the islands could not have been glaciated by ice-bergs, (1) because boulders have been carried over ridges, (2) the lower part of the Boulder-clay partakes of the nature of the rocks on which it lies, and (3) striæ may be observed running obliquely up the hill-face.

Dr. Milne Home, in his valedictory address as President of the Geological Society of Edinburgh, last year,* takes exception to some of Messrs. Peach and Horne's facts and conclusions, and attempts to show that the bearings of the striæ in Unst, as given by them, are contrary to those given by C. W. Peach at a former time.† Unless these discrepancies can be accounted for by

* *Trans. Edin. Geol. Soc.*, vol. iii., part 3, p. 357.

† Since the above was read, Messrs. Peach and Horne have replied to Dr. Milne Home's criticisms, and have shown that, when allowance is made for magnetic variation in Mr. C. W. Peach's observations, there is no discrepancy between the trend of the striæ noted by him and those recorded by Messrs. Peach and Horne.—*Geol. Mag.*, Feb. and Aug., 1881.

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the local glaciation which Messrs. Peach and Horne state to have occurred, they will somewhat interfere with the general acceptance of their conclusions. But with Dr. Milne Home's statement, that they give no evidence to prove in what direction the ice-sheet flowed, most geologists will not agree. The striæ in themselves prove little or nothing as to what direction the ice came from, but the Boulder-clay does, and, so far as the northern part of the Mainland is concerned, it clearly shows that the ice-sheet flowed in a north and west direction. I have already referred to the sections of Boulder-clay west of Hillswick. As showing some of the proofs which Messrs. Peach and Horne adduce, I quote the following :—"The sections in the neighbourhood of Ollaberry, and along the road to the Pondswater loch, show that the Boulder-clay is made up of the underlying gneissose and schistose rocks. The deposit consists of a stiff, stony clay, containing fragments of schists, gneiss, and quartz rock. None of the fragments of the diorite, nor any of the lavas and ashes along the western shores, occur in the Boulder-clay, but when the diorite area is reached, the schists and gneiss to the east are represented in small patches of the deposit lying in hollows between the *roches moutonnées*."

The first peculiarity which one observes about the scenery of Shetland is the ridgy form of the high grounds, the valleys dividing one ridge from another being deep and narrow, and at their extremities indented by long narrow voes. The valleys in most cases coincide in direction with that of the strike of the strata.

Fresh-water lochs are exceedingly numerous. Ten or fifteen may often be seen from the top of a single hill, but it is no easy matter to determine that some of them are not voes, as the latter wind in and out among the hills in most picturesque confusion.

The greater part of the coast on the east is destitute of cliffs, not so the west. Here is to be seen the grandest scenery in Shetland. Great beetling cliffs by exposure to the full fury of the Atlantic have been pierced by long gloomy caves and geos, while anon, a tall rugged stack stands sentinel over the havoc, and, as it were, guards the slow but stately retreat of the cliffs.

Amidst all the coast phenomena there is one which cannot fail to strike the geological observer as being wanting, namely,—not a Raised Beach can be detected on any of the shores of

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Shetland. Some of our best geologists have attempted to account for this by stating that Shetland has not participated in the rise of the land which took place in Scotland after the withdrawal of the great ice-sheet.

The nature of this sketch precludes me entering any further into the many interesting and fascinating topics connected with the geology of the Mainland, or any other part of Shetland; there are many more facts which I should have given, but as the remarks are intended more as an index to the "good things" in Shetland than as an account of all its treasures more facts may be dispensed with.

Plenty of good work remains to be done in Shetland, such as collecting information regarding the glacial striæ and composition of the Boulder-clay, looking for Raised Beaches, and determining the geological position of the metamorphic rocks, and there is its mineralogy, the investigation of which has already led to the solution of some important problems and is sure to lead to more.

While working out these questions the varied and picturesque [illegible] of Shetland will afford the geologist sufficient pleasure for [illegible]le he may have, while its shattered cliffs will keep him [illegible]mbrance of the terrible power of its seas, and solemnly [illegible]time when the "skeleton of a departed country" will

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## X.—Notes on the Silurian Rocks of the Muirkirk District. By David Forsyth, M.A., with a Sketch Map [Plate II.].

[Read 19th May, 1881.]

### [Abstract.]

This paper was suggested by that delivered to the Society by Dr. Hunter on the Silurian Rocks of the Logan Water, Lesmahagow.* The Silurian strata of the Muirkirk district are but combinations of those of the larger Lesmahagow area, which are best seen in the neighbourhood of Logan Water. My remarks may, therefore, be regarded as supplementary to Dr. Hunter's paper, and should be read in connection with it.

* See *ante*, p. 56.

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beds. The conformability is plainly seen in some of the smaller burns between Waterhead and Leaze Burn. In the latter burn it is interesting also to notice how several dykes produce local dislocation of strata without altering the general inclination of the beds. The upper beds of this Silurian area are much more arenaceous than the lower, evidently indicating a shallower sea than that in which the more clayey beds had been deposited.

III. *Fossils.*—*Pterygoti* have been found in all parts of the Logan Water, and in many of the tributary streams, but I have not found one in the Muirkirk area. *Ceratiocaris* is abundant, large, and in good condition in Linn Burn and Lamon Burn. *Beyrichia* is very abundant in Leaze Burn, just as it is in Blaeberry Burn, north of Logan House. Shells are generally more abundant than in the Lesmahagow district, Waterhead Ravine being especially fossiliferous. Further west, at Linn Burn and Lamon Burn, the same shells — *Lingula*, *Orthonota*, *Modiolopsis*, *Platyschisma*, (*Trochus*), and *Theca* are found, large, and in good condition. At Forkings the fossils are mostly casts, and in bad condition, while the improvement of the land has nearly obliterated the section. In the Greenock Water the strata are covered by meadowland, and only a few sections are exposed. And the same is the case with the Ponesk Burn. It is on the north side as a rule that I have found fossils most abundant.

IV. *Southern or Smaller Area.*—This strip stretches from near the head of the Douglas Water to the north-east, through Shiel Hill, to the foot of Blackwood Hill. This belt of Silurian strata is very narrow—less than a quarter of a mile—and it is therefore difficult to make out its relation to other formations. To the south it is much faulted, but to the north in many of the burns, but especially in Monk's Water and in Douglas Water, behind the farm of Parishholm, it is covered comformably by Old Red Sandstone strata. Some of the streams that join the Douglas from the south show good sections. But I have not found many fossils—*Ceratiocaris* and *Orthonota*—and these in very poor condition.

The Muirkirk district is one that has special attractions to the geologist. In the valley are Carboniferous strata, girdled by felspathic traps. These are succeeded by Old Red Sandstone rocks, and these again by Upper Silurian; so that within moderate distances three different formations can be studied. To the palæontologist the Carboniferous limestones give abundant variety of

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fossils, as do the Silurian in a less degree. To the physical geologist the relation of formations to each other, the dislocations of trappean outbursts, the local disturbances of dykes, and faults, present suggestive problems; while to the mineralogist the various coals, altered limestones, amygdaloid traps, lead and barytes veins, would well repay a visit. And, it may be added, there is now easy communication with the district by two railway routes.

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## XI.—The Volcanic History of the Old Red Sandstone Period, North of the Grampians. By John Horne, F.R.S.E., F.G.S., of H.M. Geological Survey of Scotland.

[Read 13th October, 1881.]

[Abstract.]

At the outset of his paper the author directed attention to the remarkable development of volcanic activity in Lower Old Red Sandstone times in the great midland valley of Scotland, between the Highlands and the Southern uplands. The volcanic materials, consisting of lavas and tuffs, which were erupted during that period, now form conspicuous hill ranges. They form the chains of the Sidlaws and Ochils, attaining a thickness of 6500 feet in the latter range. On the south side of the midland valley they stretch continuously from the Pentlands southwestwards into Ayrshire, where their thickness is no less remarkable. The contemporaneous volcanic rocks are there associated with great intrusive masses of quartz-felsite, the most conspicuous example of which is to be found in Tinto Hill in Lanarkshire. The volcanic action which gave rise to these great sheets of lava and agglomerate was prolonged into Lower Carboniferous times, of which there are abundant proofs in the midland valley. It is therefore an important matter to determine the proofs of volcanic activity during the Old Red Sandstone period to the north of the Grampians.

In his Monograph on the Old Red Sandstone of Western Europe, part I.,* Professor A. Geikie gave a summary of the evidence bearing on this question in the northern areas, but since

* *Transactions of the Royal Soc. Edin.*, vol. xxviii., p. 345.

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that paper was written the investigations carried on by Mr. B. N. Peach and the author in Orkney and Shetland have thrown additional light on the subject.

The records of volcanic action during Lower Old Red times are comparatively meagre in the basin of the Moray Firth, in Caithness and Orkney. It is only when we reach the Shetland Isles that we find abundant proofs of prolonged volcanic activity in the large masses of intrusive granites and felsites as well as in the sheets of lavas and tuffs. Attention was first directed to the contemporaneous volcanic rocks on the south side of the Moray Firth. In the strip of Old Red rocks stretching from Rhynie southwards to Kildrummy in Aberdeenshire a band of diabase-porphyrite occurs, which is underlaid by pebbly sandstones and conglomerates, and covered with grey and reddish sandstones. From its vesicular character, as well as from its general resemblance to some of the Old Red porphyrites south of the Grampians, it is evident that this rock is an ancient lava. Again in the Gollachie Burn, to the west of Buckie, in Banffshire, beds of diabase-porphyrite are interstratified with the members of this formation in such a way as to leave no doubt of their contemporaneous origin. At this locality the bedded volcanic rocks rest on coarse conglomerate, and are succeeded by hard red limestone and conglomerates containing rounded pebbles of diabase. Both at Rhynie and Buckie the bedded lavas occupy a higher horizon than the well known band of limestone nodules yielding ichthyolites. These are the only relics of contemporaneous volcanic action which have yet been met with on the south side of the Moray Firth, and they appear insignificant when contrasted with the great accumulations of volcanic materials in Kincardineshire and Perthshire.

In Caithness there is no trace of any interbedded igneous rocks, and in the Lower Old Red series of Orkney the sole remnant of them is met with in the south-east of the Island of Shapinshay. At this locality a band of dark green slaggy diabase is regularly interbedded with the flagstones. The upper surface of the lava flow is extremely vesicular and amygdaloidal, and the whole mass has undergone a considerable amount of alteration. Crystals of calcite are abundant in this rock, filling up elongated vesicular cavities.

In Shetland, however, the development of the contemporaneous igneous rocks is widely different. They are admirably displayed on

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the coast sections along the western seaboard of Northmavine on the Mainland and in the island of Papa Stour. In Northmavine they occupy a tract of ground about six miles in length and about two miles in breadth, between Stennis and Roeness Voe. The strata consist of purplish green and gray diabase-porphyrites, with coarse agglomerates and tuffs and occasional beds of red ashy sandstones and flags. The upper surfaces of the beds of porphyrite invariably present that vesicular appearance which is characteristic of true lava flows, the cavities being filled with calcite, green earth, and various zeolitic minerals. In that district the volcanic materials form a flat syncline, the axis of which runs approximately north and south. Along the east side of the tract they are bounded by a dislocation, which brings them into conjunction with a great intrusive sheet of granite and quartz-felsite. Again, in the bay, on the east side of Papa Stour, as well as in the voes on the north and south sides of the same island, the flaggy sandstones are interbedded with similar ancient lavas. In the conglomerates which are associated with the volcanic rocks blocks of porphyrite occur —a feature which has already been noted in connection with the conglomerate near Buckie.

In the area of metamorphosed Old Red rocks on the Mainland between Aith Voe and Sandness similar lavas and ashes are represented, but in a more highly altered form. They occur on the headlands between Aithness and Clouster, and on the western shore south of Dales Voe. Not only have the volcanic rocks undergone much alteration, but the sandstones in many places are converted into quartzites and the shales into argillites. Still, from the abundant remains of *Lepidodendron* and *Psilophyton princeps* in these strata, it is evident that the whole series is of the same age as the beds on the eastern seaboard of the Mainland, which yield similar fossils. A band of porphyrite also occurs in the Holm of Melby and a thin bed of tuff on the eastern shore of Bressay—the latter having, in all likelihood, been ejected from the necks in Bressay Sound.

In the Island of Hoy there is conclusive evidence of the continuance of volcanic action in Upper Old Red Sandstone times. At the base of the great pile of red and yellow sandstones which cover the greater part of that island, and which form the noble cliffs along the west coast, there is a mass of purple amygdaloidal porphyrite, which is undoubtedly a true lava. At the base of the

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Old Man of Hoy this bed is admirably seen spreading over the upturned edges of the underlying flagstones. Here the unconformity between the upper and lower divisions of this formation is plainly seen, and it can easily be traced northwards along the face of the cliff. At the north-western headland there seems to be a succession of lavas and tuffs, indicating successive discharges from the volcanic orifices of the period. These volcanic materials curve round the hill slopes in the north-east of Hoy, from which it is evident that they form a more or less continuous series near the base of the Upper Old Red Sandstones.

The intrusive igneous rocks of Old Red Sandstone age in these widely separated areas may be grouped in three divisions—(1) necks of volcanic agglomerate, (2) great intrusive masses of granite and quartz-felsite, and (3) dykes of quartz-felsite, rhyolite, and diabase. The necks of volcanic agglomerate represent the pipes or orifices from which some of the volcanic materials were discharged. An excellent example occurs on the shore near Duncansbay Head in Caithness, others are to be met with on the hill slopes in the north-east of Hoy, while still another series is to be found in Bressay Sound. At the latter locality the necks are arranged in a linear manner, and seem to have come to the surface along a line of fissure. The nature of the material filling these pipes varies considerably in character. Sometimes it consists of a coarse assemblage of angular fragments of sandstones, flags, and shales embedded in a finely-comminuted paste derived from the sides of the vent, while again blocks of diabase, and augite are associated with the fragmentary materials.

The intrusive masses of granite and felsite belonging to this period form some of the noblest cliffs in the Shetland Isles. They occupy wide areas in Northmavine, Meikle Rooe, Sandsting, and Papa Stour. The lithological character of these intrusive masses was briefly described in Mr. Horne's paper, and by means of coloured horizontal sections it was shown how the columnar structure so admirably displayed in the sea-cliffs is due to their having been injected in great wedge-shaped masses amongst the Old Red Sandstone rocks. Dykes of rhyolite and felsite radiate from these intrusive sheets, which vary considerably in lithological character. In addition to these, there are numerous dykes of diabase which cut through the granites and quartz-felsites, forming the closing phase of volcanic activity in the Shetland Isles.

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Reference was made to the microscopic characters of the various igneous rocks. The general type of the contemporaneous volcanic rocks displays a porphyritic ground mass with numerous small prisms of plagioclase felspar, and much interstitial augite with magnetite. In some of the microscopic sections olivine is present in well-formed crystals, though to a certain extent they have undergone a serpentinous change. Allusion was made to the spherulitic felsite of Papa Stour and to the rhyolites of Papa Little and the western seaboard of the Mainland. By means of diagrams the nature of the fluxion structure in the rhyolites was explained, which is so characteristic a feature of ordinary vitreous lavas which have been ejected at the surface. A brief description was given of certain sections where the intrusive character of these rhyolitic rocks was placed beyond doubt.

In conclusion, Mr. Horne alluded to the results of the chemical analysis of the typical igneous rocks in Shetland which at his request had been performed by Mr. Tatlock, F.R.S.E., one of the analysts for the city of Glasgow. From these results it is evident that some of the contemporaneous volcanic rocks belong to the basic series, while the granites, felsites, and rhyolites belong to the acidic group. The chemical composition of these three sub-divisions of the acidic rocks is almost identical, and the wide divergence in microscopic character is due to the different physical conditions under which these various rocks consolidated.

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## XII.—Remarks upon the Geology of the Isle of Man. By James White.

[Read 10th November, 1881.]

Were it not that your secretary always makes the smallest contributions welcome, I do not know that I would take the liberty of calling attention to the very few and commonplace specimens which I now submit to your notice. They are not pretty, and they are not rare,—a few well-known Carboniferous fossils, and a few minerals so common as copper pyrites, zinc blende, and galena, would seem to be a very small contribution to the interest of this Society's proceedings, too insignificant indeed to



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be worth me saying anything about them, or you giving up your time to listen, but for one redeeming feature, which is, that they come from a locality somewhat new to most of the members. During all the time that I have been connected with the Society, I have never seen a single specimen of rock, mineral, or fossil exhibited from the Isle of Man. The Highlands are the favourite hunting ground for tourists, for lovers of the picturesque, and for those to whom physical geology is the most attractive pursuit, whilst the economic strata of the various districts of the country are those which have been most thoroughly worked out, both in their stratigraphical and their palæontological relations. Taking advantage of some holidays, I paid a short visit last July to Manx Land, and it has occurred to me that possibly a few notes on one or two of the more prominent points in its geology, such as anyone might see on a casual visit, would not be altogether out of place.

It is truly humiliating to see how small a space this subject generally occupies in the guide-books; which devote page after page to absurd and superstitious stories, narrating with the greatest circumstantiality the ridiculous or impossible adventures of some silly monks, or chronicling every detail of barbarous battles which had much better be forgotten, while they pass over, sometimes in a single paragraph or footnote, the geology—that true physical history which has done more in the past to make men what they are, and which influences them more in the present, than any other factor of human existence. Possibly they only reflect the public taste, and if so the more is the pity.

Situated between England and Ireland, and about 75 miles in circumference, the Isle of Man is evidently the remains of strata which were at one time continuous across the Irish Sea and united the two countries. Its geology is of a very simple character, there being only three of the stratified formations represented in it, viz., the Lower Silurian, the Carboniferous, and the Drift. As you approach by steamer from the north, there are two physical features which arrest the attention,—the first is the low, receding, flat, sandy promontory, about 50 square miles in extent, which terminates seawards at Ayre Point. This is the principal area of the Drift or Post-tertiary deposits of the island. The second is the rounded, mammilated form of the hills, evidence of the rounding and smoothing action of the ice-sheet, presenting in this respect a

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marked contrast to the rugged peaks of Arran. The next strata which meet the eye as you sail along are the Lower Silurian schists, similar in character to those which line the shores of the Clyde. They are seen to perfection standing on end on the shore at Douglas, and furnish the stone of which that town is built. These form about four-fifths of the whole island. A considerable patch of Carboniferous strata occurs in the south, on the weather-beaten shore at Langness, the conglomerate being seen to rest horizontally on the nearly vertical schistose rocks, and to pass gradually and quite conformably into the limestone above. On this point Mr. Cumming writes* :—"We notice a gradual abstraction of the red matrix around the quartz pebbles of the conglomerate, and the substitution of a grey calcareous matrix instead, with a few of the lower limestone fossils imbedded; ultimately the quartz pebbles die out, and we reach the regular dark limestone beds." These limestone rocks line the shore for about five miles. On the west, in the neighbourhood of Peel, a small patch of calciferous sandstone occurs, stretching along the shore for about two miles. The town is built of it. Secondary and Tertiary rocks have no representatives in the Isle of Man, the next succeeding formation being the Drift, which consist of the usual assemblage of Boulder-clay, sands, gravels, fossiliferous clays, and other detritus. These are scattered very abundantly over the island, though specially developed in the north, and have been the subject of papers by several observers, including Professor Edward Forbes (who, by the way, was a native of the island), and Mr. John Horne, of the Scottish Geological Survey.

It is a feature of interest connected with the glaciation of this island that while there is the most abundant evidence of its having been subjected to ice-action, in the form of its hills, in the striæ of its rock-surfaces, and in the detritus left, it is also equally evident that the ice was not of local origin, but must have come from the mainland. The Cumberland hills, just visible on a clear day, are 30, while the coast of Scotland is about 20 miles distant, and from that direction and over these distances the evidence goes to show that the glaciating agent must have come.

On a bright and cheery summer day it requires a considerable effort of the imagination to call up before the mind the appearance which

* *Encycl. Brit.*, 8th ed., art. Isle of Man.

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these same seas, over which one now sails so pleasantly, must have presented when they were a "thrilling region of thick-ribbed ice," and no feature of the ice age conveys so profound an impression of its greatness as this blocking up of the firths and channels of the sea. It is an appearance which, I presume, none of us know except from pictures, and yet the case of the Isle of Man is by no means singular. Mr. James Geikie in his "Great Ice Age" calls attention to the Island of Lewis, and shows that it has been glaciated by ice from the hills of Ross-shire, 30 miles distant, and across a sea 60 fathoms deep, and we are all familiar with the evidences of the glaciation of the Island of Bute by ice from the mainland of Argyllshire, which, crossing the Kyles, passed up over the top of Barone Hill and into the sea beyond. Most of you would probably notice on the maps of the Orkney and Shetland Islands which Mr. Horne exhibited at last meeting of this Society that the glacial striæ all ran in one direction, viz., from the east and south-east, which, of course, showed that these islands were not themselves the source or nucleus of the glaciers that striated them, as in that case the striæ would have run in various directions from that nucleus, but that they must have stood in a sea of ice and have been completely covered by it. The same has been the case with the Isle of Man, but that island is a more interesting example of the ice-sheet as it is several hundreds of miles further south—glacial action being of course more intense the further north we go.

An interesting feature in the physical geography of the island, and one which seems worth noticing, is the central valley. A range of hills intersects the island from Ramsay to the Calf of Man, constituting the water-shed; numerous streams intersect its sides and form those glens and waterfalls with which it abounds. The road from Douglas to Peel, right across the island and about 12 miles in length, runs the whole way through a wide and nearly level valley, and the railway occupies the same tract without any cutting or embankment worth noticing. It seems doubtless due to the long-continued action of two of these small streams that the watershed has ultimately become cut through and two separate transverse valleys formed into one longitudinal one, in a similar way to that which Dr. Young, in his "Physical Geography," describes as having occurred in the formation of the Sound of Mull. Other examples of a similar character occur in the island. Of course

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atmospheric agencies and the sea have played a large part in widening the valley and in the final obliteration of the watershed. Just now were the land to sink only a few feet, the sea would flow through it from end to end, and we should have two separate islands. That such has been the case in recent geological time is evident, as the whole valley is filled with soft gravelly detritus.

The fossils I exhibit are from the Carboniferous limestone, where it abuts on the shore at the extreme south of the island, and from a place where they are so abundant as to give to the cliffs the local name of "the fossil rocks." Besides this section there are several quarries where the limestone is worked for burning and as a building stone, two being so close to the sea that they can only be worked at low water. The town of Castletown is built entirely of Carboniferous limestone. These fossils, which Mr. Young has been kind enough to name for me, may possibly interest some of the members, most of them being of species which are found in our own neighbourhood. In the same locality there is a quarry for a black limestone, which receives the name of Manx marble. It possesses the property of being fissile, breaking up readily into thin slabs, and is much used for mantelpieces, church ornaments and the like. The quarry-master informed me that last year he had sent 150 tons of it to England for such purposes. It is noted in all the guide-books that the steps leading to St. Paul's Cathedral are built of this marble, and that it was a present from a Bishop Wilson, who was for the long period of fifty-eight years Bishop of the Isle of Man.

It is of great interest to find these beds of the true mountain limestone cropping up in the middle of the Irish Sea. It tells a long tale of erosion, of weathering, or of denudation, call it by whatever name you will, to find the Carboniferous rocks thus worn down to their back-bone, to use a not very geological term; and it is a conclusion based upon the soundest principles of geological reasoning to say that in these outliers we have evidence of the former extension of the Carboniferous system itself in all its main features over that whole area which is now the Irish Sea.

A noticeable feature of the Isle of Man is its mines. Within a limited area there are no fewer than twelve mining stations, producing hematite, copper, zinc, lead, and silver, the iron and copper in small quantities, the zinc and galena in more abundance. Writing of the Foxdale mines, Mr. Cumming notes:—"It has

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always been found that the metalliferous veins increase in richness as they approach the granitic nuclei, the lead ore in contact with the granite and in the granite has yielded more than 100 oz. of silver to the ton."

Mr. Davies in his work on Mining and Mineralogy has this note on the Laxey mines :—"The ore is exceeding rich in silver, reaching as it does a proportion of 40 oz. to the ton of ore." Mr. R. Hunt in his Mineral Statistics for 1880, gives a list of eleven of these mines then at work in the Isle of Man, with the quantities of ore they produced and their respective values. The total quantity of ore yielded was 13,573 tons, and the total value £102,401. The specimens I exhibit are from Laxey, which is one of the principal mines, producing copper, zinc, lead, and silver. It is worked to a depth of 1400 feet, and consists of a single lode with branches. Water is the principal power used, a very large wheel, capable, when fully supplied with water, of working up to 200 horse power, keeping the mine dry. Two powerful turbines are used for drawing up the ore, which is then crushed and subjected to the action of running water, the various minerals separating out according to their respective gravities.

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## XIII.—On the Fossiliferous Strata lying between the Lower and Upper Limestones, in the Beith and Dalry District. By Robert Craig, Langside, Beith, Cor. Mem.

[Read 19th January, 1882.]

Continuing my investigation into the fossiliferous character of the rocks of this locality, the present paper in advancing order treats of the strata that intervene between the lower and the upper limestones. This includes about 100 fathoms, made up of shales, sandstones, thin beds of coarse limestones, ironstones, and coal; and contains all the coals and ironstones worked in the Dalry mineral field. As in my former papers, my object is to give a short notice of the physical and fossiliferous characters of the strata so far as known. Without attempting an exhaustive list of the fossils found, still the list appended gives the whole that

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have as yet come under my knowledge without having recourse to microscopical examination.

I do not say anything at present upon the contemporaneous age of these coal and ironstone measures, as to do so to any purpose would overburden the paper. Intending to discuss this subject in a supplementary paper, I leave it in the meantime with the following remark from Sir Charles Lyell's "Student's Elements of Geology," page 377 :—"These Scotch sedimentary beds containing coal may be older than any of the coal measures of central and southern England, as being coeval with the mountain limestone of the south." The fact that the strata, which are the subject of my remarks, lie in the middle of the Carboniferous limestone, and are therefore older than those which overlie them, bears out the correctness of the above quotation.

To simplify the paper as much as possible I have divided the whole of the strata spoken of into three groups of beds. First, from the Trearne and Howrat limestone to the main clay ironstone ; second, from this ironstone to the main coal ; and third, from the main coal to the Highfield limestone, which I make the base of the group of upper limestone beds.

*Trearne Limestone to Main Clay Ironstone.*—This group of coarse limestones, calcareous shales, thin clay ironstones, clay shales, and hard sandstones, has a thickness of about 30 fathoms. Having no commercial value, and little surface exposure in the streams of the district, and as they are carried down by the large fault that runs along the west side of the Dalry valley, the opportunities for thorough investigation of these beds are limited. My observations of the group are therefore confined to the Kerrsland Glen, where a good section is exposed, on the Pogree Burn, Beith ; to the sections on the Dusk water ; at Blairmill, Dalry, and Laverock Hall, Beith ; and to the few feet of it cut into, when baring the limestone quarries, at Waterland, Dunlop ; Dockra, Beith ; Howrat, Dalry, and others. The section at Dockra cut into was as follows :—clay shale, resting upon the ash bed, 11 feet ; fossiliferous calcareous shale, 1 foot, rich in fossils ; coarse limestone, 2 feet 10 inches ; and calcareous shale, 2 feet. This small group is rich in fossils, holding the most of the brachiopods found in the lower limestones, with a larger number of lamellibranchs, and gasteropods. *Leptodomus costellatus*, M'Coy, *Pleurotomaria*

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*contraria*, De Koninck, and *Euomphalus carbonarius*, Sowerby, here make their first appearance in the rocks of the district.

These fossiliferous beds are found at Blairmill, and at Oldmill, Beith, but appear to be absent at Howrat and Waterland, the shale there resting upon the ash-beds containing thin bands of clay ironstone, and *Lingula* remains in abundance. In the section opened at Oldmill, these shales and thin ironstones lie above the No. 1 limestone, Dockra, from which I infer the absence of the limestone at Waterland and Howrat. The section at Howrat, opened above the lower limestone, is as follows, and corresponds closely with the one at Waterland:—Clay shale, 1½ feet; clay ironstone, 3 inches; shale, 1½ feet; and clay ironstone, 3 inches. *Lingula* of large size is abundant throughout this section, but in 6 feet of clay shale cut into above this, and resting on it, it is absent.

In Kerrsland Glen the following section is exposed, both the bottom and top beds of the group being wanting, neither the lower limestone nor the main clay ironstone being seen in the Glen :—

| | | ft. | in. |
|---|---|---|---|
| 1. | Shale, . . *n.** | 9 | 0 |
| 2. | Clay ironstone, . *n.* | 0 | 5 |
| 3. | Shale, . . *n.* | 9 | 0 |
| 4. | Clay ironstone, . *n.* | 0 | 2 |
| 5. | Shale, . . *n.* | 1 | 0 |
| 6. | Impure ironstone, *n.* | 0 | 8 |
| 7. | Shale, . . *n* | 7 | 0 |
| 8. | Shale, with ironstone balls, . . *n.* | 1 | 2 |
| 9. | Shale, carbonaceous, *n.* | 6 | 0 |
| 10. | ,, calcareous, *f.* | 3 | 0 |
| 11. | Impure limestone and shale, . *f.* | 1 | 2 |
| 12. | Shale, calcareous, *f.* | 2 | 3 |
| 13. | Shale, . . *f.* | 13 | 0 |
| 14. | Limestone with attached shale, . . *f.* | 2 | 4 |
| 15. | Shale with limestone bands, . . *f.* | 7 | 9 |
| 16. | Shale, . . . *f.* | 11 | 6 |
| 17. | Sandstone, land plants, | 4 | 3 |
| 18. | Shale, . . . *n.* | 7 | 0 |
| 19. | Limestone, . . *f.* | 2 | 7 |
| 20. | Shale, calcareous, . *f.* | 3 | 0 |
| 21. | ,, . . . *f.* | 6 | 9 |
| 22. | Clay ironstone, . . | 0 | 3 |
| 23. | Shale with balls, . . | 4 | 0 |
| 24. | Coal, . . . . | 0 | 3 |
| 25. | Shale with balls, . . | 8 | 0 |
| 26. | ,, carbonaceous, . | 15 | 0 |

From this section it will be seen that I have failed to detect fossils in the lower shales of the group, which lie above the Howrat and Waterland thin ironstones. It is possible that from the argillaceous character of these shales, weathering may have destroyed the *Lingula* generally associated with the thin ironstones, but I have not found as yet any evidence to bear out that surmise.

* The beds marked *n* are nonfossiliferous, those marked *f* are fossiliferous.

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Commencing with No. 10, a group of limestones and slightly calcareous shales appear, in which marine fossils are abundant. No. 11 is a coarse limestone, divided by a band of shale, which, with the shale above it, is full of fossils. The principal are Crinoidea, Polyzoa (destroyed by weathering), Trilobites, Ostracoda, and the shells of *Orthis*, *Productus*, *Terebratula*, *Edmondia*, *Axinus*, *Cardiomorphia*, *Macrocheilus*, *Bellerophon*, and *Orthoceras*. These are all abundant, though fragile from weathering. It was from this band that *Productus plicatilis*, Sow. (?), was got—I believe its first report from Scotch beds. Fish teeth and scales are also present. The 15 feet of shale are fossiliferous throughout, but less so in brachiopods as they near their upper surface, *Aviculopecten* taking the place of *Productus*, with an occasional specimen of *Anthracosia*. The limestone, No. 14, is highly fossiliferous, with the shale overlying it. A full list of the fossils in this group is given under the heading No. 2 limestone, Kerrsland Glen, in the general list which follows this paper.

The limestone, No. 20, and shales attached, form a small group of fossiliferous beds in Kerrsland Glen, also partly exposed at Laverockhall. The limestone in both places has a curious crushed or baked appearance, as if it had been subjected to pressure while in a soft state, making it difficult to identify the fossils. In a thin band above the limestone at Laverockhall, plant remains are found associated with fine specimens of *Lingula squamiformis*, Phill. The shale above this, although very full of fossils which are found more in bands throughout the shale than distributed regularly through it, does not give many good specimens for the cabinet. In Kerrsland Glen, from the steepness and height of the cliffs the shale above the limestone cannot be examined to much purpose, and the presence of fossils is ascertained mostly from the fallen shale, known from its calcareous character. All the fossils from this group are given under the heading No. 3 limestone, Kerrsland Glen, in the appended list. The 30 to 40 feet of shale which lie above this are excluded from investigation by a vegetable covering, and from their position where exposed, overhanging the mill-dam, but from their carbonaceous character they appear to be unfossiliferous, or at least they do not contain marine organisms.

*Main Clay Ironstone to Main Coal.*—This ironstone, which is largely wrought for smelting, is not fossiliferous, a few Ostracoda, fish scales, and coprolites excepted. However, a thin stratum of

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shales upon which it rests, and another resting upon it, varying from a few inches to one foot in thickness, contain Ostracoda, *Myalina Verneuilii*, M'Coy, a species of *Axinus*, and fish remains. The shells are confined to a thin band on the immediate surface of the ironstone, and the fish remains are found throughout the stratum, though not abundantly, but there are some large spines and teeth. I have spines of *Gyracanthus formosus*, Ag., in my collection, about 2 feet long, and 7 inches in circumference near the base, and a laniary tooth of *Rhizodus Hibberti*, Ag., 4 inches in length, not entire at the point, and nearly 6 inches in circumference where it entered the jaw. In the table appended a full list is given of all the fossils which have come under my notice from this bed, some undescribed specimens excepted.

From one to three fathoms above this is a very rich fossiliferous band, varying in thickness from a calcareous shale of a few inches to a coarse limestone of 20 inches. It lies above a thin rib of ironstone and coal, immediately above which *Lingula*, scales of *Rhizodus*, and land plants are found, with, in some places, a profusion of brachiopods, lamellibranchs, gasteropods, and cephalopods. It is seen in the Dusk water at Duskyridge, Beith, and a good opportunity of investigating the fossiliferous character of the bed was found in an open section at Crookhill, Beith. When sinking a pit at Glencart, Dalry, I found in shale brought up from this horizon a fragment of *Goniatites Listeri*, Mart. (?), its first appearance in the locality, if not from Scotch beds. A few fish remains have been found, also a tooth new to science. At Crookhill the spines of *Archæocidaris Urei*, Flem., were abundant in one part of the shale, and both here and elsewhere crinoid stems are found, but not very plentifully. A list of all the fossils found is appended.

From this to the blackband ironstone a number of thin clay ironstones intervene in the strata; and in the side of a fault at Trearne, where the shales, on a horizon of 30 feet above the bed just described, are brought to a level with the lower limestone, two bands of nodular limestone and calcareous shale were found. The section stood thus:—Nodular limestone connected with shale, 11 inches; clay shale, 6 feet 9 inches; clay ironstone, 3 inches; shale, 4 feet; nodular limestone, 8 inches; shale, 4 feet; clay ironstone, 4 inches. The limestones were very full of fossils, but having the same baked character as the bed at Laverockhall, it was difficult either to procure them or to identify them. The thin ironstones and also the shale

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attached held *Lingula*, but the intervening shales were unfossiliferous. *Lingula* is the only shell generally found connected with these thin ironstones, but in one of them in Lochwinnoch parish I found *Spirifera Urei*, Flem., and in another in Carse Glen, Maich Water, same parish, a specimen of *Aviculopecten serratus*, M'Coy (?). In some of them no shells are found, and in others, where wants occur in the stone, a kind of connection is kept up by a line in the shale holding *Lingula*. An occurrence of this kind was seen in a cutting at Bellcraig, Beith, and a similar one in Swinlee's Glen. The blackband ironstone is not rich in shells; a few *Lingula mytiloides*, Sow., *Anthracoptera carinata*, Sow., *A. quadrata*, Sow., and one specimen of *Anthracosia robusta*, Sow., are all that I have obtained from the Dalry pits. In an outlier of blackband on the same horizon at Windyhouse, Beith, *Myalina Verneuilii*, M'Coy, was abundant. This is probably the blackish stone full of white shells, described by the Rev. David Ure as found at "Bogstone, near Beith."* Fish remains are also rare in this band; a few teeth of *Rhizodus*, scales of *Megalichthys*, and a fragment of an undescribed spine, are all that have come under my notice. The thin ironstones continue above the blackband, but thin beds of coal take their place as they approach the main coal. *Lingula* continues to be attached to them, and in a thin rib of ironstone about 2 inches in thickness, 17 fathoms above the blackband, near Glengarnock, *Anthracoptera carinata*, Sow., *A. quadrata*, Sow., and *Lingula mytiloides*, Sow., were in profusion. About the same horizon, or a little above it, in the Barkip district is found a bed of true marine limestone, 2½ feet in thickness. This limestone crops out in the Bombo burn at Bogfauld, Beith, and is full of crinoids, but, as far as I have examined it, few shells are found. A few small specimens of *Productus longispinus*, Sow., *Terebratula hastata*, Sow., and some fragments of doubtful specimens, are all that I have found, but from the hard character of the rock, and its slight exposure, it is impossible to investigate it to any purpose.

*Main Coal to Highfield Limestone.*—Resting upon the main coal is a thin shale holding teeth of *Rhizodus Hibberti*, Ag., and spines of *Gyracanthus formosus*, Ag., but as it is not touched in working the coal, the fossils can only be obtained in old workings where the

* History of Rutherglen and East Kilbride, Glasgow, 1793, p. 331.

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shale has fallen away, and they are therefore not often found. A part of a spine in possession of one of the proprietors in the district, is equal in size to the larger of those found above the main clay ironstone. The only fossils above this, until the Highfield limestone is reached, are plant remains, the strata being sandstones, flaggy and thick bedded, with thin beds of coal intervening. The flaggy beds are full of plant markings, but the variety is not great. The sandstones overlying the thin coal beds are in some places full of *Lepidodendron elegans*, Brongn., *Sigillaria oculata*, Brongn., *Stigmaria ficoides*, Brongn., and others. One of these beds, worked at one time, at Auchengree, Dalry, was very full of these remains, as also those of a species of fern.

In conclusion, a glance at the table of fossils will show at once the character of the strata. It is from the three fossiliferous bands found in the strata below the main clay ironstone, and the one small band found above it, that the fossils tabulated have come. The fossiliferous bands above these are many, but are all restricted to *Lingula* with few exceptions. In the 30 fathoms of strata below the main clay ironstone, over seven are highly fossiliferous, containing mostly marine organisms. In the 25 to 30 fathoms from this to the black band ironstone, there are only 3 feet holding marine fossils, and these are not persistent, being apparently formed in what may have been tracts more congenial to the existence of the molluscs than elsewhere. Then in the 30 fathoms, from the blackband to the coal, only one bed, $2\frac{1}{2}$ feet in thickness, holding true marine fossils, is found, and this of very local range. There may be other bands in these shales of the ironstone measures holding marine fossils, but at present those above mentioned are all that I have been able to detect after years of investigation.

I have again to thank my friend, Mr. John Young, F.G.S., for his great kindness in assisting me in the identification of many of the fossils. I have also to thank Dr. Traquair, M.D., F.R.S.E., for naming some of the fish remains, and for his kindness in undertaking to describe some others found in these beds, and which are apparently new to science.

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## List of Fossils found in Strata intervening between Lower and Upper Limestones.

| Species. | Lower Limestone to Main Clay Ironstone. | | | To Blackband Ironstone. | | | | To Main Coal. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1 Limestone, Dockra. | No. 2 Limestone, Kerrsland Glen. | No. 3 Limestone, Kerrsland Glen. | Main Clay Ironstone and Shale attached. Pits, Dalry. | Calcareous band, a few fathoms above Main Clay Ironstone. | Thin nodular Limestones and thin clay ironstones. | Blackband Ironstone and Shale. Pits, Dalry. | Thin Ironstones above Blackband. | Thin Limestone band below Main Coal. | Shale above Main Coal. |
| **Actinozoa.** | | | | | | | | | | |
| *Stenopora Urei*, Flem. | x | x | x | | x | | | | | |
| **Echinodermata (Echinoidea).** | | | | | | | | | | |
| *Archæocidaris Urei*, Flem. | x | x | x | | x | | | | | |
| **Echinodermata (Crinoidea).** | | | | | | | | | | |
| *Platycrinus lævis*, Miller. | x | x | | | x | | | | | |
| *Poteriocrinus crassus*, Miller. | x | x | | | x | | | | | |
| ,, *Maccoyanus*, De Kon. | x | x | x | | x | x | | | x | |
| *Pisocrinus globularis*, De Kon. | x | x | | | x | | | | | |
| *Rhodocrinus uniarticulatus*, De Kon. | x | x | | | | x | | | | |
| **Annleida.** | | | | | | | | | | |
| *Serpulites carbonarius*, M'Coy. | x | x | x | | x | | | | | |
| ,, *membranaceus*, M'Coy. | x | x | x | | | x | | | | |
| *Vermilia minuta*, Brown. | | | | | x | | | | | |
| **Crustacea (Trilobita).** | | | | | | | | | | |
| *Griffithides mesotuberculatus*, M'Coy | | x | x | | | | | | | |
| **Crustacea (Ostracoda).** | | | | | | | | | | |
| *Cythere Bairdioides*, J. and K. | x | x | x | x | x | x | | | | |
| *Beyrichia subarcuata*, J. and K. | x | x | x | x | x | x | | | | |
| *Leperditia Youngiana*, J. and K. | x | x | x | x | x | x | | | | |
| **Polyzoa.** | | | | | | | | | | |
| *Fenestella tuberculo-carinata*, Eth. | x | x | x | | | | | | | |
| *Polypora dendroides*, M'Coy. | | x | x | | | | | | | |
| *Rhabdomeson gracile*, Phill. | x | x | | | | x | | | | |
| **Brachiopoda.** | | | | | | | | | | |
| *Athyris ambigua*, Sow. | x | x | x | | | | | | | |
| ,, *planosulcata*, Phill. | | x | | | | | | | | |
| *Discina nitida*, Phill. | x | x | x | | x | x | | | | |
| *Lingula mytiloides*, Sow. | | | x | | x | x | x | x | | |
| ,, *squamiformis*, Phill. | | | x | | x | x | | x | | |
| *Orthis Michelini*, Lév. | x | x | x | | x | | | | x | |
| ,, *resupinata*, Mart. | | x | | | x | | | | | |
| *Productus fimbriatus*, J. de C. Sow. | x | x | | | | | | | | |
| ,, *carbonarius*, De Kon. | x | x | | | x | | | | | |
| ,, *longispinus*, Sow. | x | x | | | x | | | | x | |
| ,, ,, *var. Martini*, Sow. | x | x | | | x | | | | | |

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| Species. | Lower Limestone to Main Clay Ironstone. | | | To Blackband Ironstone. | | | | To Main Coal. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1 Limestone, Dockra. | No. 2 Limestone, Kerrsland Glen. | No. 3 Limestone, Kerrsland Glen. | Main Clay Ironstone and Shale attached. Pits, Dalry. | Calcareous band, a few fathoms above Main Clay Ironstone. | Thin nodular Limestones and thin clay Ironstones. | Blackband Ironstone and Shale. Pits, Dalry. | Thin Ironstones above Blackband. | Thin Limestone band below Main Coal. | Shale above Main Coal. |
| BRACHIOPODA—*Continued.* | | | | | | | | | | |
| *Productus punctatus*, Mart. | x | x | | | | | | | | |
| ,, *plicatilis*, Mart. (?) | | x | | | | | | | | |
| ,, *Youngianus*, Dav. | x | x | | | | | | | | |
| *Retzia radialis*, Phill. | x | | x | | x | | | | | |
| *Rhynchonella pleurodon*, Phill. | x | x | x | | x | x | | | | |
| *Spirifera duplicicosta*, Phill. | | x | | | | | | | | |
| ,, *glabra*, Mart. | | x | x | | | | | | x | |
| ,, *lineata*, Mart. | x | x | | | | | | | | |
| ,, *trigonalis*, Mart. | x | x | x | | x | | | | x | |
| ,, ,, *var. bisulcata*, Sow. | x | x | x | | | | | | | |
| ,, *triradialis*, Phill. | x | | | | | | | | | |
| ,, *Urei*, Flem. | x | x | | | x | x | | | x | |
| *Streptorhynchus crenistria*, Phill. | | x | x | | | | | | | |
| *Terebratula hastata*, Sow. | | x | x | | | | | | x | |
| ,, *var. vesicularis*, De Kon. | x | x | x | | | x | | | | |
| LAMELLIBRANCHIATA (MONOMYARIA). | | | | | | | | | | |
| *Aviculopecten arenosus*, Phill. | | x | | | x | | | | | |
| ,, *æqualis*, M'Coy. | | | | | x | | | | | |
| ,, *cælatus*, M'Coy. | | | | | x | x | | | | |
| ,, *concentrico-striatus*, M'Coy | | x | | | x | | | | | |
| ,, *fimbriatus*, Phill. | x | x | | | x | x | | | | |
| ,, *elongatus*, M'Coy. | | x | | | x | | | | | |
| ,, *ellipticus*, M'Coy. | | x | | | x | | | | | |
| ,, *granosus*, Phill. | | | | | x | | | | | |
| ,, *interstitialis*, Phill. | x | x | | | x | x | | | | |
| ,, *Knockonniensis*, M'Coy. | x | x | x | | x | | | | | |
| ,, *micropteris*, M'Coy. | | x | | | x | | | | | |
| ,, *orbiculatus*, M'Coy. | | | | | x | | | | | |
| ,, *plicatus*, Sow. (?) | | x | | | x | | | | | |
| ,, *variabilis*, M'Coy. | | x | x | | x | x | | | | |
| ,, *serratus*, M'Coy. (?) | | | | | x | | x | | | |
| *Pecten Sowerbii*, M'Coy. | x | x | x | | x | x | x | | | |
| *Pinna flabelliformis*. Mart. | x | | | | x | | | | | |
| ,, *spatula*, M'Coy. | | | | | x | | | | | |
| *Pteronites latus*, M'Coy. (?) | x | x | | | x | | | | | |
| LAMELLIBRANCHIATA (DIMYARIA). | | | | | | | | | | |
| *Anthracoptera carinata*, Sow. | | | | | | | x | x | | |
| ,, *quadrata*, Sow. | | | | | | | x | x | | |
| *Anthracosia aquilina*, Sow. | | x | | | | | | | | |
| *Anthracosia robusta*, Sow. | | | | | | | x | | | |

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| Species. | Lower Limestone to Main Clay Ironstone. | | | To Blackband Ironstone. | | | | To Main Coal. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1 Limestone, Dockra. | No. 2 Limestone, Kerrsland Glen. | No. 3 Limestone, Kerrsland Glen. | Main Coal Ironstone and Shale attached. Pits, Dalry. | Calcareous band, a few fathoms above Main Clay Ironstone. | Thin nodular Limestones and thin clay ironstones. | Black band Ironstone and Shale. Pits, Dalry. | Thin Ironstones above Blackband. | Thin Limestone band below Main Coal. | Shale above Main Coal. |
| DIMYARIA—*Continued.* | | | | | | | | | | |
| *Axinus axiniformis*, Phill. | x | x | | | x | | | | | |
| ,, *carbonarius*, Portl. | x | x | | | x | x | | | | |
| ,, *deltoideus*, M'Coy. | x | x | x | | x | | | | | |
| ,, *sulcatus*, Sow. | x | | | | x | | | | | |
| *Arca clathrata*, M'Coy. (?) | | | | | x | | | | | |
| ,, *Lacordaireana*, De Kon. | | x | x | | x | | | | | |
| *Cardiomorpha oblonga*, Sow. | x | x | | | x | | | | | |
| *Cypricardia rhombea*, Phill. | | x | x | | | | | | | |
| ,, *striato-lamellosa*, De Kon | x | x | | | x | | | | | |
| *Edmondia oblonga*, M'Coy. | x | x | | | x | | | | | |
| ,, *compressa*, M'Coy. | | x | | | x | | | | | |
| ,, *gibbosa*, M'Coy. | | x | | | x | | | | | |
| ,, *quadrata* M'Coy. | | x | | | x | | | | | |
| *Leda attenuata*, Flem. | x | x | x | | x | | | | | |
| ,, *oblonga*, M'Coy. | x | x | | | x | | | | | |
| *Leptodomus costellatus*, M'Coy. | x | x | x | | x | | | | | |
| *Modiola lingualis*, Phill. | | x | | | | | | | | |
| ,, *lithodomoides*, Eth. | x | x | | | x | x | | | | |
| *Myacites sulcata*, Flem. | x | x | | | x | | | | | |
| *Myalina crassa*, Flem. | | x | | | | | | | | |
| ,, *Verneuilii*, M'Coy. | | | | x | | | x | | | |
| *Nucula acuta*, Sow. | | x | x | | x | | | | | |
| ,, *gibbosa*, Flem. | x | x | x | | x | | | | | |
| GASTEROPODA. | | | | | | | | | | |
| *Dentalium inornatum*, M'Coy. | x | x | x | | x | | | | | |
| ,, *Scoticum*, J. Young. | x | x | | | | | | | | |
| *Eulima Phillipsiana*, De Kon. | | x | | | | | | | | |
| *Euomphalus pentangulatus*, Sow. | | x | | | | | | | | |
| ,, *carbonarius*, Sow. | x | x | | | x | | | | | |
| *Loxonema brevis*, M'Coy. | x | x | | | x | | | | | |
| ,, *Lefebvrei*, Lév. | x | x | | | x | | | | | |
| ,, *rugifera*, Phill. | | x | | | | | | | | |
| ,, *sulcatula*, M'Coy. | x | x | x | | x | | | | | |
| *Macrocheilus acutus*, Sow. | x | x | x | | x | | | | | |
| ,, *imbricatus*, Sow. | x | x | | | x | | | | | |
| ,, *Michotianus*, De Kon. | x | x | | | x | | | | | |
| ,, *tricinctus*, M'Coy. (?) | | x | | | | | | | | |
| *Murchisonia quadricarinata*, M'Coy | | x | x | | x | | | | | |
| ,, *striatula*, De Kon. | | x | | | | | | | | |
| *Naticopsis canaliculata*, M'Coy. | x | x | | | x | | | | | |
| ,, *variata*, Phill. | x | x | | | x | | | | | |
| ,, *plicistria*, Phill. | x | x | | | x | | | | | |
| *Pleurotomaria contraria*, De Kon. | x | | x | | | | | | | |

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| Species. | Lower Limestone to Main Clay Ironstone. | | | To Blackband Ironstone. | | | | To Main Coal. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1 Limestone, Dockra. | No. 2 Limestone, Kerrsland Glen. | No. 3 Limestone, Kerrsland Glen. | Main Clay Ironstone and Shale attached. Pits, Dalry. | Calcareous band, a few fathoms above Main Clay Ironstone. | Thin nodular Limestones and thin clay ironstones. | Blackband Ironstone and Shale. Pits, Dalry. | Thin Ironstones above Blackband. | Thin Limestone band below Main Coal. | Shale above Main Coal. |
| GASTEROPODA—*Continued.* | | | | | | | | | | |
| *Pleurotomaria conica*, Phill. | x | x | | | x | | | | | |
| ,, *monilifera*, Phill. | x | x | x | | x | | | | | |
| ,, *Yvanii*, Lév. | x | x | x | | x | | | | | |
| *Turbo biserialis*, Phill. | x | | | | | | | | | |
| *Trochus lepidus*, De Kon. | | | | | x | | | | | |
| HETEROPODA. | | | | | | | | | | |
| *Bellerophon cornu-arietis*, Sow. | | x | | | | | | | | |
| ,, *decussatus*, Flem. | x | x | x | | x | | | | | |
| ,, ,, *var. striatus*, Flem. | x | x | x | | | | | | | |
| ,, *Urei*, Flem. | x | x | x | | x | x | | | | x(?) |
| PTEROPODA. | | | | | | | | | | |
| *Conularia quadrisulcata*, Sow. | x | | | | | | | | | |
| CEPHALOPODA. | | | | | | | | | | |
| *Nautilus biangulatus*, Sow. | x | x | | | x | | | | | |
| ,, *quadratus*, | | x | | | x | | | | | |
| *Orthoceras cinctum*, Sow, | | | x | | | | | | | |
| ,, *cylindraceum*, Phill. | | x | | | x | | | | | |
| ,, *attenuatum*, Flem. | x | x | x | | x | | | | | |
| ,, *Goldfussianum*, De Kon. | | x | x | | x | | | | | |
| ,, *dentaloideum*, Phill. | x | | | | x | | | | | |
| ,, *subcentrale*, De Kon. | x | x | | | x | | | | | |
| ,, *undatum*, Flem. | | x | x | | x | | | | | |
| PISCES. | | | | | | | | | | |
| *Cladodus mirabilis*, Ag. | | x | | | | | | | | |
| *Tomodus convexus*, Ag. | x | x | | | x | | | | | |
| *Helodus didymus*, Ag. | x | x | | | | | | | | |
| *Petalodus Hastingsiæ*, Owen. | x | x | | | | | | | | |
| *Megalichthys Hibberti*, Ag. | | | x | x | x | x | x | x | | x |
| *Acrolepis Rankinei*, Ag. | | | | x | | | | | | |
| *Acanthodes Wardi*, Ag. | | | | x | | | | | | |
| *Elonichthys* sp. (?) | | | | x | | | | | | |
| *Rhizodus Hibberti*, Ag. | | | | x | | | | | | |
| *Ctenacanthus hybodoides*, Ag. | | | | x | | x | | | | x |
| *Gyracanthus formosus*, Ag. | | | | x | | x(?) | | | | |
| ,, *tuberculatus*, Ag. (?) | | | | x | | | | | | x |
| *Homocanthus microdus*, Ag. (?) | | | | x | | | | | | |
| *Nematoptychius Greenockii*, Ag. | x | | | x | | | | | | |
| (?) (?) | | | | | x | | | | | |
| (?) (?) | | | | x | | | | | | |
| *Glyptocanthus confluens*, P. N. Young | | | | x | | | | | | |

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# XIV.—Notes on the Origin and Early History of The Geological Society of Glasgow. By Thomas M. Barr, M.Inst.C.E., Perth.

[Read 13th April, 1882.]

Situated as Glasgow is, in the centre of a district full of interest to the geologist, and drawing much of its wealth and importance from the extensive mineral fields by which it is surrounded, it was to be expected that the science of geology would early attract the attention of many living in the city, as well as of others in the district, who had perhaps even better opportunities for observation and research. Indeed, the wonder is that systematic study of the science should have been so long delayed. Geology, in its practical department, is closely allied to the search for hidden treasure, and Scotchmen are usually credited with being keenly alive to whatever affects their material interests. They may, indeed, be too cautious to put faith in the "Philosopher's Stone," but they are firm believers in any kind of stone which can be made a marketable commodity. It was not, however, in any mercenary spirit that the founders of "The Glasgow Geological Society" set about their labours. The actuating principle was simply a desire for knowledge—a longing to learn more of the mysterious structure of this wonderful creation on which we live and move; and I think it may be said with all confidence that every member of our Society has found himself amply rewarded by the knowledge he has attained and the pleasure he has derived from the prosecution of his studies. I can, at all events, say so much for myself, and the grateful feelings I entertain towards the Society have induced me to endeavour to put its early records in such a form as may prevent them being forgotten or lost altogether.

Before entering upon the origin and history of this Society it may be interesting to notice some of the previous attempts to form associations for the systematic study of geology, and the then existing means available for the diffusion of a knowledge of the science. I shall, therefore, endeavour to do this so far as time and opportunities have permitted, but as these have been very limited my sketch will consequently be incomplete. Other members may, however, be able to supplement it, so that we may yet have a tolerably complete history of the rise and progress of the study of geology in our city and district.



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That the science did prove attractive to a popular audience may be inferred from the fact that one of a course of popular lectures delivered in the old Mechanics' Institution in Ferguson Street, Cowcaddens, when I was a small boy at school, was devoted to geology. The lecturer was the late Rev. Dr. Eadie, and his special object was to show the harmony between the observations and teachings of geologists, and the Mosaic account of the creation. The lecture would not now perhaps be accounted very scientific, but we must remember the vast strides that geology has made since that time. I can remember little of the lecture, but the effect remaining on my mind was so decisive that I never afterwards was disturbed by the fears and suspicions with which many have regarded the science and those who have devoted themselves to its study. About the same time Mr. Michael Connal, one of the members of our Society, had a class for young lads who met in the Spout-mouth, and it was his practice to walk out with them, on the Saturday afternoons during the summer months, to interesting country localities for the study of botany and geology.

I have been informed that an effort was made to establish a geological society in the city before 1850, but I have not been able to obtain any particulars, and the most reliable information seems to show that it never went further than a discussion of the project. At this period the local geologists appear to have communicated the results of their observations through the Philosophical Society, *e.g.*, Dr. James Bryce read a paper on the 'Parallel Roads of Lochaber,' on 6th March, and another on 'The Geological Structure of Roseneath,' on 17th April, 1850.

The first geological society in Glasgow appears, therefore, to have been that formed in 1850, when, as the minutes bear:—"At a conversazione held by the members of Mr. John Craig's class at its close, in Laming's Coffee House, 108 Argyle Street, on Monday evening, 1st April, 1850, Mr. A. M. Fyfe proposed that the members form themselves into a Society for the advancement of the study of geology, which proposition was carried by acclamation, and a committee was appointed to draw up rules for the management of the Society."

This committee met in the same place on the evening of the 9th April, when a draft of the rules was prepared, and agreed to be submitted at the first meeting of the Society, on the first Tuesday in May, Mr. Fyfe agreeing then to read a paper on "Primary

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Formations." The meeting was accordingly held on 7th May in Picken's Coffee House, Mr. Craig in the chair. The draft rules were submitted and agreed to; rule No. 1 being "That this Society shall be denominated 'The Glasgow Geological Society,' and that it shall have for its object the further advancement of the science among its members." The minute continues:—"The Society proceeded to elect office-bearers, when the following gentlemen were agreed upon:—Mr. John Craig, *President*, Mr. Robert Barr, *Vice-President*, Mr. Donald Campbell, *Secretary*, Mr. A. M. Fyfe, *Curator*, Mr. David N. Chambers, *Treasurer*. *Directors*—Messrs. John Parker, W. C. Pattison, Provan, James M'Ewan, Hennedy, and Cameron. Mr. Fyfe then read an excellent paper on 'Primary Formations,' tending to prove that geology had a beginning, which gave great satisfaction to the members and a vote of thanks was tendered to him. Mr. Campbell was ordered to read the next paper, which was to be on 'The Cambrian and Silurian Rocks.'"

In addition to the names above given there appear to have been the following members at this time:—Messrs. Wm. D. Elliot, A. M. Humphrey, James Mavor, and Wm. Black. The next meeting was on 3rd June, when Mr. Campbell read a paper on 'The Lower Palæozoic Rocks,' embracing the varied stratified formations of the Cambrian and Silurian systems, with their origin, position, and fossiliferous contents, together with the wonderful structure exhibited in the formation of these early inhabitants of the globe. Mr. Barr was ordered to read a paper on the 'Old Red Sandstone,' at the Society's first meeting which was ordered for Tuesday, 8th October. The President then gave his parting address prior to leaving this country for the Rocky Mountains."

The next meeting was on 8th October, 1850, but Mr. Barr, instead of reading his paper on the Old Red Sandstone, gave the Society some extracts and communications from their late President's letters about his voyage to America and also his geological prospects there.

The next meeting was in Picken's Coffee House on November 5th, 1850, when "Mr. Barr read an interesting letter from Mr. Craig, of Iowa, anent the discovery of some frogs in alluvial deposits, after which Mr. Barr read an admirable paper on the Old Red Sandstone."

"December 3rd, 1850, met this evening the Glasgow Geological

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Society in Picken's Coffee House, when Mr. Mavor read an interesting and valuable paper on the 'Coal Fields of Great Britain,' which elicited considerable discussion tending to improve the members generally. Mr. M'Ewan was ordered to read a paper on 'The Iron Fields and Manufactures of Great Britain.'"

The next meeting on 7th January, 1851, was devoted to the reading of some interesting information sent by Mr. Craig from Iowa, relative to geological discoveries he had made there. The minute of next meeting proceeds:—"On 4th February, 1851, met the Glasgow Geological Society. Mr. M'Ewan read a most elaborate paper on 'Iron—its Ores and Manufactures,' and was highly complimented by the members for the trouble he had taken in placing such a production before the Society. It was agreed that Mr. Kennedy Gill should read the next paper on Tuesday, 4th March; the subject being 'Copper—its Ores, &c.'"

The minutes abruptly terminate at this point—the likelihood being that there were no other meetings, as the Society did not exist a full year—but they are interesting as indicating how the members proceeded to carry out the study of geology. It will be observed that they appear to have first set themselves to a general study of the great formations, rising from the Primary to the Carboniferous; that is, those formations which were easily accessible from Glasgow. They then seem to have taken up the economic uses of the rocks, and aimed at going through them systematically. Another feature is that the minutes almost invariably state that a member "was ordered to read a paper," as if there was some degree of compulsion. How would that work in our Society now?

Having traced out some of the members of this old Society, I am by their aid enabled to supplement the minutes in several particulars where they appear to be incomplete. No mention is made of the late Mr. Smith of Jordanhill, yet a deputation from the Society, consisting of Messrs. Craig, Campbell, and Fyfe, waited upon him by appointment, and asked him to accept the office of President. Mr. Smith received the deputation most courteously, and after a conference, in which he entered very fully upon the best way of conducting the Society, he closed by saying, that from his age, and from his being so seldom in town, especially at night, he thought they would do better with a president from among themselves, but if his name would do any good he would gladly become Honorary

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President, and would charge himself to attend the anniversary meetings at least. Mr. Smith afterwards occupied the chair on the occasion of a farewell dinner, in one of the hotels in town, in honour of Mr. Craig, previous to his leaving with his family for Iowa, and on that occasion he gave a most interesting account of the Geology of the Clyde Basin.

Another noticeable circumstance connected with the minutes is the absence of all reference to any excursions by the Society, from which it might reasonably be inferred that its work was restricted to the reading and discussion of papers. This would, however, be a mistake, as, on my applying for information on this point to Mr. Fyfe, he wrote in reference to excursions:— "I can speak quite definitely as to these, and I think there were five, or perhaps six. The first was to the Kilpatrick Hills. We took steamer to Bowling and walked to Mr. James Ewing's gates on the Leven, where the gamekeeper was in waiting for us. Mr. Craig told him what we were in search of, and he immediately conducted us to the place on the very brow of the hill, where he left us. We spent some hours about, and were rewarded by many very beautiful specimens of gypsum, pure, very white, fibrous, and exquisitely crystallized. I have some of them still, and would recommend any walking geologist to take a tramp there, it was so abundant, and being in private grounds I cannot suppose it exhausted. It was perhaps a mile from the brow of the hill due SE. from the gates, on the edge of a wide sheep-track before turning due south to Bowling Pier. I remember a ludicrous incident when walking down the hill towards Bowling, eight or ten of us, very tired, and most of us with bags over our shoulders. When nearing a gentleman's house we were observed, and being mistaken for visitors and friends of the proprietor, the family piper turned out and played a Highland welcome. Great was his indignation when he discovered the mistake, and folding up his pipes he walked off quite ashamed of his blunder. The next excursion was to Dalry, where we found abundance of very fine encrinites in a limestone quarry. The third was to the neighbourhood of Coatbridge, but I recollect little of it. The other excursions are so mixed up in my memory with walks by two or three of us, which were not infrequent, that I must not venture to detail them."

After the breaking up of this society, the popular study of geology seems to have reverted to the old desultory system of dis-

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jointed lectures and papers read at the Philosophical and other societies, whilst there was an undercurrent working in less influential circles. There was founded on 9th December, 1854, a Mutual Improvement Association composed of students attending the Glasgow Mechanics' Institution, North Hanover Street, and as the only limitation made by the directors of the Institution was, that no political or religious subject was to be discussed, the field was wide enough to take in geology; although I remember on one occasion a member objecting to an essay on that subject on the ground that it would lead to discussing theological questions. His objections were, however, over-ruled, but it serves to show the light in which the science was viewed in those days. Accordingly we find in session 1855 one of the essays was a 'History and Sketch of Geology.' During the same session a deputation of the students waited upon the directors to urge on them the claims of geology as a subject to be taught in the Institution, suggesting a summer class similar to that for botany so long taught by Mr. Roger Hennedy. This was so far successful, as we find in the 33rd Annual Report, dated May, 1856:—"The committee, at the request of the students of the previous session, advertised for a Lecturer on Geology and Natural History, but they were unsuccessful in meeting with an efficient Lecturer. In consequence, a course of lectures on Popular Anatomy and Physiology was instituted, and has been ably conducted by Dr. James Steven."

In session 1856-7 the programme of the Mutual Improvement Association comprised a series of four essays by as many members, taking up different sections of geology in a somewhat systematic arrangement. In the same winter, Dr. John Taylor took Geology as the latter part of his course of Popular Evening Lectures at the Andersonian University, and this seems to have been the first attempt made in our city to popularise the science by giving a comprehensive course of lectures on it. The first lecture was delivered on the evening of 12th January, 1857. Dr. Taylor defined geology as "one of the sciences which are occupied in the study of nature. It inquires into the past condition of the earth, both as to its structure and its relations to the sun and other planets." After explaining the astronomical aspects of the science, and the relation of our earth to the other heavenly bodies, and the probable origin of the earth as a gaseous and then a fluid mass before it became solid, Dr. Taylor gave a general description of

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the earth, and stated that in his course of lectures he proposed to consider—first, the minerals; next, the important classes of animals; and third, the most important classes of plants. The lectures were continued weekly till the 28th April, when the session closed. The first four were devoted chiefly to the earth as a whole, and its relation to the other members of the solar system. The lecturer entered very fully into the various theories as to the origin of the earth, and the arguments advanced in support of them; his previous lectures on mechanics and natural philosophy giving him great advantages in dealing with this part of the subject, as they enabled him to go much more into detail than he could otherwise have done with an ordinary popular audience. The conclusion arrived at, stated generally, was that the earth had originally passed from a gaseous to a fluid state, that the solid crust was now about 24 miles in thickness, but that about 1,000 miles of thickness, being influenced by the moon's attraction, were probably in a viscous or semi-fluid state, and the remainder was still fluid.

Dr. Taylor then took up the leading minerals, as quartz, felspar, mica, hornblende, augite, calcareous spar, gypsum, and chlorite, and, passing on to the rocks, first described the two great classes, volcanic and aqueous. When he came to treat of the fossiliferous rocks, he diverged into zoology, describing the four great classes of radiata, mollusca, articulata, and vertebrata, and their various subdivisions. He treated botany in the same manner. The students were thus enabled to follow the lecturer intelligently through his descriptions of the various fossiliferous beds, and understand the varying conditions of life which they indicated. A comprehensive view was thus given of the whole science of geology, and although the field was much too extensive to be handled in an exhaustive manner, it must not be supposed that it was treated superficially. On the contrary, by numerous exercises given out to be worked at home, particularly on the first branch of the subject, and by periodic examinations on special nights set apart for the purpose, Dr. Taylor sought to make his teaching as thorough and efficient as circumstances would permit, and those who knew him will remember what a wonderful faculty he had for awakening in his students an enthusiasm almost equal to his own, and of exciting their interest in whatever subject he took on hand.

Dr. Taylor had at least three excursions with his class. The

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first was on Saturday, 24th Jan., to Stobcross, where there was an extensive deposit of stones from ship's ballast, which afforded an opportunity of seeing a variety of rocks. The second was on Saturday, 4th April, by 2·10 P.M. train to Campsie (now Lenzie) Junction, the party walking thence to Corrie Glen, and returning to the Junction. Geological excursions were not so common in those days as they are now, and quite a sensation was caused by the party passing through Kirkintilloch. Personally, Dr. Taylor was tall and thin, wore his hair very long, and usually had his hat stuck on the back of his head. He threw as much energy into his walking as he did into everything he undertook, and it was no easy matter to keep up with him. No wonder, therefore, that his appearance in the village, followed, or rather pursued, by a straggling tail of fifty or sixty individuals of various sorts and sizes, mostly equipped with bags and hammers of portentous aspect, should have caused a complete stagnation in the local manufacturing industry. Every weaver quitted his loom, and ran to see what was causing the unwonted stir out of doors, and various guesses were hazarded as to what all this could mean. It so happened that there was a general election about the same time, and the conclusion most favoured seemed to be that this unwonted display had a political significance, although this would hardly account for the hammers. Fortunately, the neighbouring Woodilee Asylum was not erected then, or there is no saying what the natives might have thought. The third excursion was on Saturday, 25th April, to the Hunterian Museum, then at the old College in High Street. Mr. Thomson reminds me of a fourth excursion, to Robroyston, which had escaped my memory, as I was prevented taking part in it. This course of lectures, as before stated, terminated in April, 1857, a year before the formation of our Society.

Next session, 1857-8, Dr. Taylor's course of lectures was devoted to Mechanics, and there were no lectures on Geology at any of the Institutions in the city till the winter of 1858-9, when a course was delivered in the Mechanics' Institution, by Mr. Thomas Struthers, then the head teacher in the Trades' School. Mr. Struthers also lectured in the same place during the winters of 1863-4, and 1865-6, the Rev. H. W. Crosskey afterwards becoming the lecturer during the sessions of 1866-7, 1867-8, 1868-9. There were no lectures in 1869-70, but they were resumed in the following winter, and continued uninterruptedly till 1881-2, when

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they were discontinued. Dr. Page lectured in 1870-1, Dr. Robert Brown in 1871-2, 1872-3, and 1873-4. Our esteemed Vice-President, Mr. John Young, began his course in 1874-5, carrying it on successfully till its close in 1881-2.*

Having thus sketched, as fully as the available sources of reliable information would permit, the early efforts made to further the study of geology, and form a geological society in Glasgow, we may now turn to consider the particular course of events which led to the formation of our existing Society.

In connection with Free St. Peter's Church (under the pastorate of the late Rev. William Arnot), there had been for many years a very flourishing Young Men's Society, which held weekly meetings during the winter season from September to May, and at which papers were read and discussed on various subjects, among them geology appearing to have found a place. Thus the minutes bear that on 6th November, 1857, Mr. James Binnie "read his essay on geology, being the second of the course on the wisdom and goodness of God illustrated from science."

There had been a feeling growing among the members that it was undesirable to break up all connection during the summer months, and occasional excursions or picnics were made to the country, but some of the leaders thought it would be better to have more systematic arrangements and some definite end in view. Accordingly, at the annual business meeting held on 23rd April, 1858, Mr. Morrison, Vice-President, in the chair, the minutes state—"It was proposed by Mr. Hugh Reid and agreed to, that a special meeting of the Society be held next Friday evening for the purpose of considering the following suggestions submitted to the Society by Messrs. Parker and Waddell, Vice-Presidents, viz.:—

"1st. The starting of a manuscript magazine in connection with the Society.

"2nd. The organization of excursion parties for intellectual improvement during the summer recess."

It is interesting at this point to note the connection between this movement, and some of the earlier movements already

* In the summer of 1882 a new Geological Lectureship was founded in Anderson's College by Dr. James Young, of Kelly, Mr. John Young being appointed the first lecturer, and we hope he may long be spared to continue a class which has always proved a valuable feeder to our Society.—December, 1882.

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described. Mr. Parker, whom we now find taking the lead in this, is the same Mr. John Parker, formerly a member of Council in the Geological Society in connection with Mr. Craig's classes eight years before; and his coadjutor, Mr. J. Gray Waddell, was for many years (previous to 1855) secretary to the popular evening classes at the Andersonian University.

The special meeting was accordingly held, as we find from the minute:—"Within the session-house on the evening of Friday, 30th April, 1858, was held a special meeting of Free St. Peter's Young Men's Society. Mr. Parker, Vice-president, occupied the chair, and opened the meeting with prayer. . . . . The Chairman having stated his ideas regarding the members forming themselves into sections for the study of 'natural science' during the summer recess, and several members having supported them, two sections (botanical and geological) were resolved upon. The organization of each to be distinct, and separate from that of the Society."

The minute only mentions that "a considerable number of members were present"—probably about twenty-five to thirty—and all present, except four, elected to join the botanical section. The four who selected geology were, William Kirkland, Hugh Reid, Thomas M. Barr, and George M. Barr, and there was a good deal of merriment at the smallness of their number. These four had meetings in the session-house on the evenings of the 5th and 10th May following, to consider what was best to be done under the circumstances. They felt their number to be too small to make a successful geological section, and yet they were unwilling to abandon the idea, as there was reason to believe that a sufficient number of the public were interested in the study of geology to make a strong society. They ultimately resolved to put an advertisement in the newspapers, calling a meeting of all willing to join such a society and also inquiring as to any similar society which might be already in existence for the study of the science.

This meeting was accordingly held, and perhaps the better way is to let the minute speak for itself:—"Free St. Peter's Vestry, 17th May, 1858. Met Messrs. Wünsch, Rae, Thomas M. and George M. Barr, Fergus Ferguson, James Ferguson, Gray, Alex. Ross, and Kirkland, who agreed that they, along with such members as may hereafter join them, shall constitute a Society for the study of geology.

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"The following was agreed to as a basis of constitution:—

"1st. Name—That the name of this Society be 'The Glasgow Geological Society.'

"2nd. Objects—That its objects be to promote amongst its members the study of practical geology. That excursions be made by members at convenient periods to geological districts in the country, and that the services of a practical geologist be obtained to accompany and assist them in their examination of geological phenomena.

"3rd. Meetings—That meetings be held monthly (or oftener if found necessary) for reading papers and having conversations upon the science, and for exhibition of objects connected therewith.

"4th. Fee—That the subscription be 5s. for the summer season, and a small subscription be made in winter if found necessary.

"That the business of the Society be managed by a President, Vice-President, and four Members of Committee.

"The following parties were elected:—*President* (left blank); *Vice-President*—Edward Wünsch; *Secretary and Treasurer*—William Kirkland; *Committee*—Alex. Ross, Thos. M. and Geo. M. Barr, and James Rae, with power to add to their number.

"The Secretary stated that he had inserted as directed a notice in the *Scottish Guardian*. That the only letter he had received in reply was from a society (formed of some members of Dr. Lindsay's class) called 'The Glasgow Natural History Society,' advising our joining them. After consideration it was concluded that that Society did not give that prominence to geology nor the facilities for its study which were desiderated, but that the Secretary should correspond with them for co-operation.

"A communication was read from Mr. Parker stating that a Society existed for the prosecution of General Science, and that as this was the proper season they might be willing to prosecute geology, particularly this summer. The Vice-President and Secretary were appointed to inquire into its nature, and, if satisfied, upon what terms they would admit this Society as a distinct Geological section."

"Mr. Parker further states in his communication, that having waited upon Dr. Bryce, the latter mentioned that, owing to his numerous duties at the present time, he was unable to give a lecture to the Society. He recommended a Mr. Cowan, of Barr-

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head, as a properly qualified person to accompany the members in that district.

"The Secretary stated that he had seen Mr. Young, of Campsie, recommended by Mr. Keddie, Mr. Frazer, and other geologists, and that he stated that he could not undertake to accompany the members, except to Campsie districts, and that these would afford four profitable excursions. The sum of £1 was agreed to as the amount of remuneration for the services stated, and that Mr. Young be informed that the members could not avail themselves of his services on Saturday the 22nd inst., as originally proposed."

"Mr. Colin Brown, Virginia Street, having been proposed as a very suitable person for President of the Society, the Vice-President and Secretary were appointed to wait on him, with the view of inducing him to accept the office."

"It was agreed to hold the monthly meetings of this Society on the second Thursday of each month, and that the next meeting be held in M'Callum's Coffee House, at 8 P.M."

The only remarks I would make upon this minute are, that from the second and fourth heads of the constitution, there is evidence that the members seem mainly to have had in view the original idea of a summer session with excursions. There seems also a slight mistake as to the proper name of the Society which replied to the Secretary's advertisement. The Society formed from Dr. Lindsay's class at the Andersonian University was instituted on 21st April, 1858, and was designated "The Glasgow Naturalists' Society." The change of the place of meeting was thought to be advisable, as the members now aimed at a wider range of membership than that originally contemplated.

The next meeting was accordingly held in M'Callum's Coffee House, Glassford Street. "M'Callum's Coffee House, 24th May, 1858, the Glasgow Geological Society met. Present—Messrs. Wünsch, Clark, Thomson, Dickson, George M. and Thomas M. Barr, Fergus and James Ferguson, Reid, Gray, Halliday, Rae, Armstrong, and Kirkland, who enrolled themselves as members of the Society. Mr. Wünsch occupied the chair. The minutes of last meeting were read and approved of.

"The Secretary stated that in accordance with the minutes of last meeting, a letter had been sent to the Natural History Society, meeting in Dr. Lindsay's."

"The Vice-President and Secretary had been making inquiries

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regarding the Natural History Society, in order, if a satisfactory arrangement could be made, to co-operate with them, but had not been able to obtain as yet any information. The above parties were re-appointed. The Secretary reported that he had seen Mr. Brown, who expressed himself gratified at our formation into a society, and at his having been nominated President. His business arrangements would, he was afraid, prevent his acceptance, but he would consider the matter. He promised that meantime he would assist us in any other way which lay in his power. The Vice-President was appointed to wait on him again, and in the event of Mr. Brown not accepting, Mr. Connal was suggested as a very proper person to occupy the position of President. The Secretary stated that he had written Mr. Young, of Campsie, in accordance with previous minutes, and that in reply he received a letter accepting of the terms there proposed, and stating the following as four suitable excursions :—

"1st. South Hill and Craigenglen. The former having been formed by denudation, the latter as being highly charged with fossils.

"2nd. North Hill and Campsie Glen. The former hill is capped with lofty terraces of trap. In the Glen are to be seen the junction of the trap with the Carboniferous beds, and the effects produced by the heat of the volcanic rocks.

"3rd. Corrieburn. Sections of strata of coralline, and encrinal limestone and shales, belonging to the mountain limestone series of the coal formation, and also junctions of the trap with the sedimentary rocks.

"4th. Spout of Ballagan. Vast series of thin bedded limestones and shales. The finest view of stratification in that quarter. Gypsum and jasper are found in the strata at the Spout. Dunglass Hill, opposite Ballagan, in the middle of the valley, a beautiful mass of columnar basalt.

"Some members having expressed themselves as gratified with the information which the letter conveyed, manifesting as it did Mr. Young's thorough acquaintance with the subject, it was then agreed that the four excursions be undertaken, and the first be made to Campsie on Saturday, 29th inst., at 2·10 P.M. It was further agreed that as this excursion was a preliminary one, each member should be at liberty to take a friend with him.

"It was resolved that a notice of the Society being now estab-

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lished, and of the trip to Campsie, be sent to the Athenæum, Glasgow Public Library, Andersonian University, and other suitable places, and that the said notice be inserted in the *Herald* of Wednesday, *Mail* of Thursday, and *Bulletin* of Friday succeeding.

"It having been considered that many members of Dr. Taylor's late class might be induced to join, the following were appointed a special committee to canvass for them:—Mr. Peter Halliday, Mr. James Armstrong, Mr. James Thomson.

"The following committee was also appointed to enlist members from Free St. Peter's Young Men's Literary Society:—Mr. G. M. Barr, Mr. T. M. Barr, and Mr. Hugh Reid."

From this minute it is evident that the Society had now been fairly set agoing, and the members were earnestly addressing themselves to the work for which it was constituted, and at the same time seeking to extend the membership, so as to establish the Society on a solid foundation.

The first excursion of the Society took place, as arranged, on Saturday, 29th May, 1858, a party of twenty-five leaving Dundas Street Station by the 2.10 P.M. train for Campsie Junction, and walking thence by Kirkintilloch and Milton to Lennoxtown, where Mr. Young met them at the road leading to the Alum Works. Turning up this road, the party followed the Alum Works Burn to the South Hill, examining the boulders and beds exposed, and then passed on to Craigenglen, where a considerable time was devoted to gathering fossils. Having spent a most enjoyable afternoon, the party started to walk back to town, which was reached about half-past 10 o'clock. Most of the members were well laden with 'specimens,' but it is to be feared that in many cases, for want of discrimination, the bulk was out of all proportion beyond the value.

The Society met in M'Callum's Coffee House on 31st May, when Messrs. Lang, Arneill, Carey, Yuille, York, and Winton joined as members. "It was stated that owing to the Secretary (Mr. Hunter Finlay) being ill, no communication had yet been received from him regarding 'The Natural History Society,' meeting in the Religious Institution Rooms. Committee continued.

"The Secretary reported that the first excursion of the Society had taken place on the previous Saturday as arranged, and Messrs. Thomson and Arneill were appointed to draw up a report of the excursion, to be read at the first monthly meeting; and as several

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of the members had been unable to join in the excursion, it was agreed that a second should be made over the same ground on Saturday, 5th June."

The attention of the Society was now directed to securing a fixed place of meeting. Messrs. Wünsch and Carey were appointed to make arrangements for accommodation at the Athenæum, and it was agreed that the first monthly meeting on Thursday, 10th June, be held there. There is, however, no trace of this meeting being held. Probably something may have occurred to occasion its postponement, but the next minute is dated "Athenæum, 17th June, 1858.—Mr. Wünsch, V.P., in the chair. Messrs. Horne, Dove, Naismyth, A. T. Williams, and Downes enrolled. It was reported that the second excursion had been made to South Hill, Campsie, and Craigenglen, under the guidance of Mr. Young, and a report of it prepared by Messrs. Thomson and Arneill was read by Mr. Thomson. Some conversation took place as to the desirability of getting up a library in connection with the Society, but further consideration of this was deferred. Mr. Horne also suggested the propriety of taking steps to form a museum. The third excursion was fixed for 19th inst. to the North Hill, Campsie, Messrs. Lang and Armstrong to prepare a report of it."

The third excursion was accordingly made on Saturday, 19th June, the party leaving Dundas Street Station about one o'clock for Lennoxtown, where they were met by Mr. Young. Walking about two miles along the Strathblane road, they reached Campsie Glen, passing up which they had an opportunity of observing the various junctions of trappean and stratified rocks. Crossing the Fintry road, and passing along the face of the North Hill, they ultimately reached the lime quarries, where some time was spent in fossil-hunting, after which they returned to the city by train.

The Society met in the Athenæum on 1st July, 1858. Mr. Lang read a report of the excursion to Campsie Glen and the North Hill. The fourth excursion was fixed for Saturday, 3rd July, to Corrieburn. Messrs. Wünsch and Kirkland were appointed to prepare a report, and it was also agreed, on the suggestion of Mr. Horne, that specimens obtained should be exhibited for the benefit of members who might be unable to accompany the excursion.

A question arose at this meeting which gave rise to some differ-

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ence of opinion, and the discussion was renewed in connection with some of the other excursions. In those days the surrounding districts were not opened up by railways to the same extent as now, and it being difficult to get to some of the localities, except by hiring special conveyances, the point was whether these should be hired by the Society *qua* Society, or be hired by the individual members who took part in the excursions. The minute proceeds, "The meeting having considered it desirable that an omnibus be engaged for this excursion, the Secretary stated that Mr. Menzies would supply the vehicle for 45s. for not more than 25 persons. After consultation, it was found only 13 members could agree to avail themselves of the conveyance. This number being insufficient, Mr. Lang proposed, and Mr. Armstrong seconded a motion, 'That for this trip an omnibus be engaged by the Society, that those availing themselves of it be charged 2s. 6d.; the loss, if any, to be sustained by the Society, and the surplus, if any, to accrue to its funds.' Mr. Thomson (Nile Street) moved, and Mr. Arneill seconded, an amendment, 'That the members availing themselves of this conveyance defray all its expense.' On a show of hands, the motion was declared carried."

At a subsequent meeting on 22nd July, the Secretary reported that 17 members had gone by the 'bus, and, at 2s. 6d. each, there was a deficiency of 2s. 6d., which it was agreed should be met by each of the members who had gone paying 2d. additional. There was nothing said as to what was to be done with the surplus of 4d. The same question was discussed in connection with the trip to Ballagan, Messrs. Lang and Armstrong moving, "That an omnibus be engaged by the Society, and members going pay 2s. 6d. each;" and Messrs. Arneill and Ferguson moving an amendment, "That members availing themselves pay the whole expense." The amendment was carried by a large majority. The funds of the Society were very limited, and one section of the members was jealous of any risk being incurred. The other argued that as the members who went got all the hard work and contributed specimens and reports for the benefit of the whole Society, it was unfair to make them take all the risk of the hires.

There was another matter in connection with the excursions which came up for discussion several times, and was at last settled by a sort of "standing order," which does not appear to have been minuted. It was to the effect that at an excursion of the Society

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no member was to propose an adjournment to a hotel or public-house. There was no interference with individual liberty, but the object aimed at was that no one, while on a Society's trip, should be made to feel singular by not going into such places. It is but right to say that this was only a precautionary measure, nothing having ever occurred, so far as I am aware, to call for such a rule. The only general adjournment I remember was on one occasion when at Ballagan on a very wet afternoon. It rained all the time we were driving out and when on the hill-side, so that we were very glad to get back to the village sooner than usual, only, however, to find that the horses were not sufficiently rested to resume the journey. There was no shelter available except in the half public-house and half farm, where the horses were put up, and the whole party was soon crowded into the kitchen, to wait till the 'bus was ready. There was no lack of animal spirits, and, in our drenched condition, lots of good-natured 'chaffing' at each other. One of the party, with a good deal of the 'superior person' in his manner, discovering a large pot on the fire, said to the girl attending, "Ha, here's something hot; this will suit me." She naively replied, "Maybe it will; it's the cauf's supper."

To resume our narrative in chronological order. The fourth excursion was on Saturday, 3rd July, to Corrieburn, when 17 members left George Square by omnibus at half-past two, and drove to Corrieburn, where they were met by Mr. Young, who had walked over from Lennoxtown. After spending some hours in the glen, they got back to town about half-past ten.

A special meeting was held on 20th July, to consider "an offer made by Dr. Bryce, through Mr. John Parker, to act as guide to the members should they choose to visit Arran." It was agreed to accept of this offer, and a party went, but it was not very numerous, few of the members being able to spare the necessary time.

The next ordinary meeting was held in the Athenæum on Thursday, 22nd July, when the Secretary read a report of the trip to Corrieburn, and it was agreed to have a trip to Ballagan Glen on Saturday, 31st inst.

"Attention having been called by Mr. Armstrong to the constitution and rules of the Society, Mr. Lang moved, seconded by Mr. Armstrong, 'That a Committee, consisting of the Vice-Presi-



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dent, Secretary, Messrs. Horne, Armstrong, Halliday, Ross, Lang, Barr, and York, be appointed to draw up a code of new rules, and submit it to next meeting,' which was agreed to."

The sixth excursion was to Ballagan Glen on Saturday, 31st July, by omnibus starting from George Square about two o'clock. This was, perhaps, one of the most enjoyable trips of the season. Mr. Menzies invariably sent four finely-matched grey horses, with driver and guard in neat blue uniforms with silver-lace facings, the 'turn out,' as we drove through the streets, attracting considerable attention, and serving as a capital advertisement of the Society. Then as we went bowling along under the 'Pen Brig' (now being demolished), through Maryhill and Milngavie, and over the hill towards Strathblane, where the Blane Valley comes into view, with Ben Lomond and his rugged neighbours for a background, there was a buoyancy and exhilaration of spirits which we miss in the prosaic railway journey of the present time. On this afternoon the weather was particularly fine, and after reaching the 'Spout,' a small party climbed to the top of the hill, and enjoyed the magnificent prospect of hill and dale, lake and mountain, reposing in all the glory of a golden sunset. It was a small party, and the members have since been scattered 'wide as the world' apart, yet doubtless that summer evening still lingers as a bright spot in the memory of every survivor. As marking the progress made in our geological knowledge since then, it may be interesting to note that Mr. Young on that occasion, in describing the Ballagan beds, mentioned that it was not considered settled whether they were of Lower Carboniferous or of Old Red Sandstone formation, although generally believed to be the former. He also mentioned that they were not found further west than in Auchenreoch Glen, near Dumbarton. They have now been identified as far west as Loch Thom, on the Greenock hills. After inspecting the Spout of Ballagan, the party crossed the Lennoxtown Road, and ascended Dunglass Hill to view the columnar structure of the basalt and a travelled boulder on the top. Driving home, we reached the city about 10 p.m.

The next meeting was in the Athenæum on 12th August. At this meeting it was proposed that an endeavour should be made to arrange with the Directors of that Institution for more permanent accommodation. The committee appointed at the previous meeting submitted a report, and after consideration, a code of twelve rules

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was agreed to. As they have never been printed it may be interesting to give them here complete.

Name. I. That the Society be called "The Glasgow Geological Society."

Objects of the Society. II. That its object be to unite into a recognised body all the friends and advocates of geological science residing in Glasgow and surrounding districts, and to encourage and cultivate geological science generally.

Government. III. That the affairs of the Society shall be conducted by a council of management consisting of nine, viz:—a President, Vice-President, Secretary, and six members of the Association, who shall be elected at the annual General Meeting of the members in the October of each year.

Membership and Subscriptions. IV. Persons desirous of joining the Society are admitted on application to the President or Secretary, or by introduction of a member, on the payment of an annual subscription of 7s. 6d., or separately for the summer or winter session, 4s. each respectively. A donation of 20s. shall entitle the donor to membership for three years.

Honorary Associates. V. Persons distinguished as geologists, or known as friends and advocates of geological science, shall be eligible for admission as Honorary Associates, upon a recommendation by two members, and election by a majority of the members present at meetings when they are proposed. They shall enjoy all the privileges of members, but shall not be required to pay any subscription.

Museum and Library. VI. A geological museum and library shall be formed as soon as found expedient. Bye-laws to be added for their regulation.

Meetings of Members. VII. The regular monthly meeting of members shall take place on the first Thursday of each month, but the Council or Secretary may at any time call a special General Meeting, and shall be bound to do so on the written requisition of ten of the members, specifying the nature of the business to be transacted. At all general meetings of members the resolution of the majority shall be binding.

Annual General Meeting. VIII. The annual General Meeting shall take place on the first Thursday of October of each year.

Funds. IX. The Secretary shall receive and pay all monies, keep regular account of the same, and have a balance of accounts prepared every six months, to be audited by two of the Council.

Excursions and Lectures. X. During the Summer Session the members will visit interesting geological districts under the guidance of a practical geologist, and in the winter session lectures and papers will be read by the members and Honorary Associates bearing on

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the science, specimens of fossils, &c., exhibited, and discussions carried on.

Sessions. XI. The Summer Session to commence in the middle of April, and continue till the middle of September. The Winter Session to commence on the first Thursday of October, and end the first Thursday of March.

Alteration of Laws XII. No alteration shall be made in these rules except at a General Meeting of the Society, specially convened for this purpose. Such alteration shall be tabled at one meeting, and discussed at a subsequent one, and shall not be adopted unless agreed to by two-thirds of the members present."

The seventh excursion was on Saturday, 21st August, to East Kilbride, and the limestone quarries in that neighbourhood.

The eighth was on 28th August to Bishopbriggs quarries, and Auchenairn, the freestone quarries being then in full operation in that district, though now abandoned. The 'tirring' was very heavy, and some of the quarries were worked by mining.

Up till this period Mr. Young had acted as conductor at all the Society's excursions, except that to Arran.

The ninth excursion was to Hurlet and Barrhead on 4th September, the members going by train to Hurlet and walking thence to Barrhead. The chief feature of this excursion was the examination of glacial action. Mr. Cowan acted as conductor.

The monthly meeting was held in the Lower Hall of the Athenæum on 9th September, Mr. James Horne in the chair, in absence of the Vice-President. Reports were read of the three trips which had been made since the previous meeting, and it was agreed to have another trip to the Barrhead district on the 11th, and one to Coatbridge on the 18th September, which should terminate the season's excursions. A letter was read from Mr. Young with regard to forming a museum, in which he said, "If you could manage to get hold of the collection locked up in the Andersonian, and which was purchased by money subscribed by the people of Glasgow for the meeting of the British Association, it would enable you to lay the foundation of your museum. It is all a Scotch collection, and a great part of it is from the neighbourhood of Glasgow." (Is it yet too late to inquire as to this?) In view of arranging for the winter session the Secretary moved, and Mr. T. M. Barr seconded, that Messrs. Reid, Horne, York, and Armstrong, be appointed provisional members of Council.

The tenth excursion was made on 11th September, and was

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conducted by Mr. Cowan. On this occasion the party went by rail to Kennishead, where some sandstone and limestone quarries were visited. They then walked to Hurlet, and visited the Alum Works, some of the more active going down the Townhead Pit in the alum shale. This was no joke, as the descent and ascent were made by a series of ladders; but once down the pit the exploration was easy enough. The only mishap was that two of the party got separated from the main body. One of their lamps had gone out, and in trying to light it, the other lamp was stumbled against, and it too was extinguished, leaving the luckless pair in darkness and afraid to move. Being missed, however, a search party was formed, and retracing their steps, the benighted men of science were soon relieved.

The eleventh excursion (and last of the season) was made on 18th September to Coatbridge and Baillieston. The party left Buchanan Street Station about half-past two, taking the train to Coatbridge and walking back. After following the Monkland Canal a short distance, they came to the Glasgow Road. At a pit close to the roadside near Baillieston they spent a considerable time on the shale-heaps, where some very fine specimens of ferns, chiefly *Pecopteris* and *Neuropteris*, were obtained, and after getting their bags well filled, they continued their walk back to Glasgow. On the way home the party had the satisfaction of viewing "Donati's Comet," then appearing in the northern sky. It was prominently visible for a considerable time afterwards, but as the period of its revolution is 2495 years, it is not likely to be seen again at any of the Society's excursions.

The summer season being now over, the Society addressed itself to the winter's work. At a special meeting held on the 23rd September, it was agreed to accept the terms, offered by the Directors of the Athenæum, for six months' accommodation. Mr. Horne reported that Mr. Colin Brown was unable, from business engagements, to accept the office of President. A Committee was therefore appointed to wait on Mr. J. P. Fraser, to ask him to accept the Presidentship.

The first annual business meeting of the Society was held in the Board-room of the Athenæum on 7th October, when the Committee appointed to wait on Mr. Fraser reported that he had consented to accept the office of President. He was elected with acclamation, and thus became the first President of the Society. "The financial statement of the summer session, from 13th May

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till 7th October, was then submitted, audited by Messrs. Barr and Ross. Receipts, £8 11s. 6d.; expenditure, £8 6s. 3d., leaving a balance in the Secretary's hands of 5s. 3d. Mr. Lang proposed, and Mr. Morrison seconded, the following gentlemen as office-bearers for the ensuing year:—*President*—J. P. Fraser, F.R.S.E., F.G.S.; *Vice-President*—E. A. Wünsch; *Council*—Messrs. Horne, York, Armstrong, Carey, Williamson, and Crosskey.

"Mr. Kirkland, owing to other engagements, tendered his resignation as Secretary. It was, however, arranged that he should hold office until a suitable successor should be elected."

During the session 34 members in all had joined and paid the subscription.

The winter session was opened on the 4th November, when the President delivered a lecture in the Lower Hall of the Atheneum, on 'Glacial Action'—Mr. Wünsch, V.P., in the chair.

The next meeting of the Society was on 18th November—the President in the chair—when the Secretary intimated that he had received a number of geological specimens, chiefly Silurian, from Dr. Sloan of Ayr. Mr. Wünsch introduced the subject of a course of four lectures by Mr. D. Page, which had been considered by the Council. The Directors of the Athenæum had been approached, but they declined to co-operate with the Society in engaging Mr. Page. They may have thought the new society rather ambitious in seeking their alliance, or perhaps, as they had engaged the Duke of Argyll to give a lecture on 'Geology: Its Past and Present,' on the 13th January, they thought that was as much geology as the citizens could stand in one winter. After some discussion, it was resolved to make an effort to raise a guarantee fund to provide against possible loss, and the Secretary was authorised to treat with Mr. Page as soon as £15 was subscribed. This was accomplished in a very short time, and Mr. Page engaged to give four lectures on 'The Past and Present Life of the Globe,' in the Merchants' Hall, Hutcheson Street, in January and February, 1859.

The next meeting was in the Lower Hall of the Athenæum on 2nd December, the President in the chair, when Mr. Young delivered a lecture on 'The Geology of the Campsie District.' This lecture was printed in 1860, a list being appended of the fossils found in the district, and formed the first publication issued by the Society. It was illustrated by three sections—one across the valley at Ballagan, looking west, one across the valley at Lennox-

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town, looking east, and a longitudinal section along the North Hill, from Strathblane to Corrieburn. These sections do not seem to have been given in the second edition, which was printed after the first was exhausted.

The next meeting was in the Athenæum Board-room on 16th December, at which final arrangements were made for Mr. Page's lectures. Mr. Dennison, mining engineer, gave a description of the Lanarkshire coal-fields, and thereafter presented to the Society a section he had prepared showing the strata.

On 14th January, 1859, Mr. Williams in the chair, the President gave a second lecture on 'Glacial Action.'

On 20th January, Mr. A. Williams read a paper on 'The Geology of Arran,' illustrated by a map and several sections, which he had prepared.

The first of Mr. Page's lectures on 'The Past and Present Life of the Globe,' was delivered in the Merchants' Hall on 27th January, the President, Mr. J. P. Fraser, in the chair; the chairmen at the other lectures being—1st February, Mr. Walter Crum; 3rd February, Dr. James Bryce; 8th February, the President. The Hall was well filled every night, Mr. Page being accompanied to the platform each evening by Prof. Rogers, Dr. Allen Thomson, Mr. William Keddie, Mr. Walter Crum, Rev. Wm. Traill, &c. These lectures were also a financial success, as instead of requiring to call up the guarantee fund, there was a surplus of about £7. It was afterwards agreed to present £3 of this sum to Mr. Page, making up his fee to £20, in acknowledgment of the very handsome manner in which he had treated the Society during the negotiations. The Society also added 57 to its membership during the Lectures.

The remaining Lectures of the Winter Session were:—

10th February, in Lower Hall of the Athenæum, when Dr. Bryce gave a lecture on 'The Geology of Arran.'

17th February, when Mr. Wünsch, Vice-President, read an essay on 'Volcanic Rocks.'

3rd March, a lecture on 'The Igneous and Metamorphic Rocks' was given by Prof. John Scouler, M.D., LL.D., F.L.S.

17th March, an essay on the 'Geology of the South Downs of Sussex,' by Rev. Mr. Crosskey, was given. At this meeting the Secretary read an abstract financial statement for the Winter Session, 7th October, 1858, till 17th March, 1859, audited by Messrs. Hugh Reid and G. M. Barr. Receipts, £62 6s. 6d.;

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Expenses, £50 7s. 3d.; balance in Secretary's hands, £11 19s. 3d. There appear to have been 99 members on the roll at this time.

Having thus completed a sketch of the Society's first summer and winter sessions, a very interesting testimony to its success from the outside may be here introduced. We have seen that the suggestion which led to its formation originated with Free St. Peter's Young Men's Society, and although the societies were quite independent, a connection was maintained for some time. It is not surprising to find the elder keeping an eye on the proceedings of the younger. In the report of the Directors, read at the annual business meeting of the Young Men's Society on 29th April, 1859, referring to the business of the special meeting agreed to at the previous annual meeting, they state:—"The Botanical Section, under the guidance of Mr. Parker (to whom the credit of originating the movement is due), made regular excursions into the country for the collection of plants, and weekly meetings were held for their classification. The members of that section admit having received much benefit, physically and mentally, from their rambles. They look back with pleasure to the past, and forward with hope to the future. They cordially invite all the members inclined to that delightful study to join their ranks.

"The Geological Section, under the able convenership of Mr. Kirkland, has been more ambitious than its fellow. It has grown into an institution numbering among its members (now above 100) some of the most distinguished scientific men of the city and district. This section is now known as the 'Glasgow Geological Society.' During the season, under its auspices, lectures have been given by several eminent men. They correspond with leading geologists in all parts of the country. They also have had excursions during the summer months, for the collection of specimens, to different districts, and such an impetus has been given to the study of geology, that it is said the price of fossils has already risen. The miners and quarrymen have come to see at last one kind of value in the old 'stane fish.' One other fact in connection with this may be mentioned. It will be most interesting to members to know that a society has been formed in London on the model of that which Free St. Peter's Young Men's Society originated in Glasgow." *

* This may refer to the "Geologists' Association," which originated from a letter signed W. J. Haywood, in the *Geologist* of August, 1858,

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At the next annual business meeting of Free St. Peter's Young Men's Society, on 27th April, 1860, the Directors report:—"The section for the study of botany was not resumed last year, but during the recess the members had a trip to Balloch and Loch-Lomond, on Queen's Birth-day."

No further reference is made in the minutes of that Society to either the Geological or Botanical Section. The Botanical one does not seem ever to have been revived.

A meeting of the Geological Society was held on the 14th April, 1859, at which the arrangements for the Summer Session were fixed. These comprised six excursions to the Campsie district. 1st. Ballagan Glen, and Dunglass Hill. 2nd. Craigmaddie Moor and the Auld Wives' Lift. 3rd. Alum Works Burn and Craigenglen. 4th. Millburn and Ferret's Glen. 5th. Balgrochan Glen. 6th. Corrieburn. Besides these, there were, during the summer, excursions to Auchenreoch Glen, East Kilbride, and Bishopbriggs, and the Society also inaugurated this year the Queen's Birthday Pic-nic, the spot selected for this excursion being Spittal Glen. Dr. Scouler, Dr. James Bryce, and Mr. John Young, of Campsie, were unanimously elected Honorary Associates, being the first elected by the Society.

"The first excursion of the season was to Ballagan on the 7th May, but it was an unpleasant contrast to our visit the previous season, a fine forenoon being succeeded by a very wet afternoon and evening, which marred the enjoyment of the members."

On 7th July it was agreed "to hold fortnightly meetings during the summer for the purpose of exhibiting, naming, and exchanging fossils, and for conversation thereon."

The second annual business meeting was held in the Religious Institution Rooms, on 6th October. Up till this date the whole of the office-bearers were elected annually, but as this was found inconvenient a change was made in the Rules. The following extracts from the minutes will show the more important business of the meeting:—

"The following amendment on Rule III. was proposed by Mr.

leading to a meeting being held on 29th November, at which a Provisional Committee was appointed to take steps for the formation of a society. A prospectus was issued on 6th December, and the first meeting of the Association was held on 11th January, 1859. The programme and aims of that Association are similar to those of our own Society.

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T. M. Barr, seconded by Mr. Campbell, and agreed to, 'That the affairs of the Society shall be conducted by a Council of 16, viz., a President, two Vice-Presidents, and a Secretary, each of whom shall be elected annually, and twelve members of Council, six of whom shall retire annually, but shall be eligible for re-election. The election to take place at the annual meeting in October of each year, and shall be conducted in the following manner. The name of each gentleman nominated, after being proposed and seconded by two of the members, shall be written down by the Secretary. Each member shall then write on a slip of paper the names of those for whom he votes, and those gentlemen having the greatest number of votes shall be declared duly elected. Should any vacancy occur during the year, it shall be filled up by the members of the society at the first business meeting after the notification of such vacancy.' Mr. Horne proposed, and Mr. Henderson seconded, an amendment on Rule IX. to the effect, 'that the balance of accounts be audited by two members of the Association, instead of two members of Council.' Agreed to.

"The Secretary submitted a statement of accounts for the past six months, from 17th March till 6th October. Receipts £15 16s. 9d., and expenses £13 8s. 7d., leaving a balance of £2 8s. 2d. in favour of the Society. The Vice-President and Secretary thereafter tendered their resignations of their respective offices, which were accepted.* The meeting then proceeded to the election of office-bearers for the ensuing year, when there were elected :—*President.*—Mr. J. P. Fraser, F.G.S., F.R.S.E. *Vice-Presidents.*—Messrs. Thos. Struthers and John Young. *Secretary.*—Mr. James Horne. *Council.*—Messrs. E. A. Wünsch, James Armstrong, Wm. Kirkland, T. M. Barr, James Thomson, John Dennison, William Carey, H. W. Crosskey, J. C. Douglas, Wm. Johnstone, James Stewart, and Thomas Henderson. . . .

"Mr. Young stated that the collection of the late Mr. Cowan was for sale at present, and that it might be obtained for about twenty pounds. A subscription was originated among the members present for the purpose of acquiring it for the Society. £7 8s. 6d. were subscribed."

This was the same Mr. Cowan who had acted as guide to the

* These were Mr. Wünsch and Mr. Kirkland, who had been respectively Vice-president and Secretary from the inauguration of the Society.

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Barrhead district, at the Society's excursions of the previous season. He died from the effects of an accident. The Society was ultimately successful in securing his collection for the museum.

The principal features of the ensuing Winter Session were, a second course of four lectures by Mr. Page, on December 1, 7, 15, and 22, the subject being 'The Geological Aspects of the Coal Formation'; a lecture on 'Earthquakes and Volcanoes,' by Professor Rogers of the University; and essays on various subjects by members of the Society, including 'British Mining,' by Mr. Mark Fryar, 'Certain points of contact between Geology and History,' by Dr. Bryce, 'Succession of Extinct Organic Forms,' by Mr. Wm. Keddie, 'Relative Antiquity of Existing Species,' and 'Osteology,' by Dr. Scoular. There was also a course of lectures conducted by Mr. Thomas Struthers, V.P., and intended to teach the rudiments of the science to beginners. The meetings on the whole were well attended, and the Society made fair progress, although it had to contend against the counter attractions of the 'Volunteer movement,' which was entered upon very enthusiastically by the young men of the city during this season.

Such then is a sketch of the origin of our Society, and of its work during the first two years of its existence. I have already mentioned that Mr. Young's paper on the 'Geology of the Campsie District,' was published in 1860, but although headed 'Transactions of the Glasgow Geological Society,' it does not bear any further reference markings, as if the editor was not at all sanguine of having any more 'Transactions' to publish. A second edition of this paper was published in 1868, and is marked 'Vol. I, Part I.' The second publication was a paper on 'The Phenomena of the Glacial Drift of Scotland,' by Professor Arch. Geikie, in 1863. A second issue of this has also been made, the first having been entirely sold out. In 1865 the minutes of the Society's meetings were included in the *Transactions*, so that from that time there is a clear record of the Society's work.

The rules were printed for the first time in 1860. These were revised and altered in 1864-5, and again in 1874-5. Another illustration of the truth of the saying, that 'Constitutions are not made, but grow.'

The first complete list of the members was issued in 1860, and gives the names and addresses of 178 members. It was lithographed in view of a general canvass to increase the

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membership, as it was thought desirable that members should know who were already on the roll. On looking over the last list, printed in 1876-7, it will be found to contain the names of five members who joined in 1858, and seven who joined in 1859. Of these several have since dropped off, so that those who participated in the early struggles of the Society are fast disappearing. It may be interesting to mention that all the four with whom the idea of starting the Society originated are still alive, but only one, Mr. William Kirkland, is now resident in Glasgow; Mr. Hugh Reid is in Cardiff, and Mr. G. M. Barr in Otago, New Zealand, whither he went in 1862. 'Men die, but mankind has an enduring existence,' so, although the old members pass away, there are new members stepping into their places, and the Society has now an assured position, little dreamt of when it was first started. Several of the members have distinguished themselves in special fields of investigation, as Mr. James Thomson, in the 'Corals,' Mr. James Dairon, in the 'Graptolites,' Mr. Wünsch, in the 'Arran Volcanic Ashbeds,' Mr. David Robertson, in the 'Post-tertiary Deposits,' and there is no greater living authority than Mr. John Young on the 'Geology of the whole of the West of Scotland district.' Good work has also been done by other members, so that the Society may fairly claim to have made its mark on the progress of the science. Its 'coming of age' was duly celebrated. Let us hope that when its 'jubilee' comes round it may be celebrated under even more auspicious circumstances, and that when the members then pause to look back, they may be interested to know something of the origin and early history of their Society.

NOTE [*Feb.*, 1883].—I have just had my attention called to evidence of the existence of a "Glasgow Geological Society" in November, 1840, from the handbill, just presented to the Society by Mr. John Wilson, of which a copy is subjoined.

I have not, however, been able to find any other trace of this Society. I have made inquiries of some of the old members of Mr. Craig's classes, and of others whom I thought likely to be able to give me information on the subject; but not one of them had even heard of the existence of a Geological Society in the city in 1840.

Mr. Craig was a mineral surveyor, and he taught several classes during the winter seasons. It is possible that the advent of the British Association may have induced the members of some of those classes to assume the title and try to establish a society, but the attempt does not seem to have been attended with much success, or to have left any other evidence of its existence than the notice in this old handbill. T. M. B.

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UNDER THE PATRONAGE OF THE HONOURABLE THE

# LORD PROVOST & MAGISTRATES

## OF GLASGOW,

## THE VERY REV. PRINCIPAL MACFARLAN,

*VICE-PRESIDENT OF THE BRITISH ASSOCIATION,*

**AND PROFESSORS OF THE UNIVERSITY.**

# MR CRAIG

Most respectfully announces that he proposes giving TWO LECTURES on the

## GEOLOGY & MINERAL RESOURCES OF THE WEST OF SCOTLAND,

IN THE

## TRADES' HALL,

ON THE AFTERNOONS OF

**MONDAY and WEDNESDAY, the 7th and 9th Dec. at 3 o'Clock.**

The same Lectures will be repeated on the Evenings of the same days at a Quarter past 8 o'clock.

## THE FIRST LECTURE

Will illustrate the phenomenon connected with the Trap Formations of the West of Scotland; the Minerals peculiar to these; their modes of occurrence and origin; the Alluvial and Diluvial Deposits, with the evidences they afford of the Changes of the relative Levels of Sea and Land. Also, a general view of the Nature of the Metamorphic Rocks, Conglomerates, and Red Sandstones of Argyle and Dumbarton shires, and the adjacent Coasts.

## THE SECOND LECTURE

Will embrace, with many additions, the substance of Mr CRAIG'S Paper, laid before the last meeting of the British Association, viz.—A Description of the Coal Formations of the Counties of Lanark, Renfrew, Dumbarton, and Ayr, with notices of the Vegetable and Animal Remains characteristic of the different Divisions of the Stratification.

The Lectures will be illustrated by Diagrams and Drawings, and the Maps and Sections prepared by Mr C. for the Glasgow Committee of the British Association, and exhibited at the recent Meeting in Section C, and by Specimens of the Rocks, Minerals, and Organic Remains.

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"Glasgow College, 18th Nov. 1840.

"We consider that the above Lectures are well worthy of public patronage, and that Mr CRAIG'S exertions in developing the mineral resources of the country are worthy of every encouragement.

"WILLIAM COUPER, Professor of Natural History.
"THOMAS THOMSON, Professor of Chemistry.
"J. P. NICHOL, Professor of Astronomy.

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"Glasgow College, 24th Nov. 1840.

"I concur in the above recommendation.
"D. MACFARLAN, Principal, Vice-Pres. Brit. Asso."

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EXTRACT FROM THE GLASGOW NEWSPAPERS OF SEPTEMBER, 1840.

"Dr Buckland, no mean authority on such a subject, stated that Mr Craig's paper was the most important practical communication ever laid before the British Association."

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**Tickets, admitting to both Morning Lectures, 3s. 6d. each—to both Evening Lectures, 2s. each: Admission to a Single Lecture—Morning, 2s. Evening, 1s. 6d.**

To be had of Messrs John Smith & Son, 70 St. Vincent Street; J. Finlay, 40 Buchanan Street; Thomas Murray, 8 Argyle Street; D. Robertson, 188 Trongate; John M'Leod, 20 Argyle Street: A. Rutherglen, 84 Trongate; John Morrison, 27 Bridge Street; and the different Members of the Glasgow Geological Society.

Glasgow, 25th Nov. 1840. W. & W. MILLER, Printers, 90 Bell Street.

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## XV.—The Bismuth and Tin Deposits of Australia. By James R. M. Robertson, M.D. With Map and Diagrams. (Plates III. and IV.)

[Read 9th February, 1882.]

The stanniferous deposits of Australia extend over large areas of the colonies of Queensland, New South Wales, South Australia, and Tasmania, and from them a large proportion of the total Tin production of the world has for some years past been derived. New South Wales ranks first in respect to production of Tin, Tasmania second, Queensland third, while discoveries of the ore in the northern territory of South Australia were only reported a few weeks before my departure from the colonies in October of last year. As the same description will practically apply to the whole of these colonies, I will dwell somewhat in detail on the first discovered, and up to this time the most prolific, Tin-field of the group, viz., that of the mother colony of New South Wales.

If you will be kind enough to look at the rough map which I have prepared (Plate III.), you will observe an irregular patch, shaded with diagonal lines, on the N.E. frontier of the colony, which shows the extent of the Tin-producing area. A similar patch on the southern boundary of Queensland shows an extension of the deposits into that territory, and in both Tin is found under precisely similar conditions.

In the northern territory of Queensland this valuable metal has been found, in recent years, distributed over two very extensive areas; where, in addition to alluvial ore, numerous wonderfully rich lodes have been opened up. There is at present good reason to suppose that from her northern territory alone, Queensland will in the near future, if sufficient capital can be introduced, take precedence of all the other colonies in the production of Tin.

The part of New South Wales, where the Tin deposits are found, is called New England, the principal towns being Glen Innes, Armidale, and Inverell. The whole of this district may be considered as a table-land, elevated about 3000 feet above the sea. It is surrounded and intersected by hill ranges, and the scenery is distinctively highland and of a high order. The backbone of the district is granite, which, where exposed, has been eroded and weathered, so that it has assumed many curious and fantastic forms, giving rise to some gigantic examples of Logan stones, one

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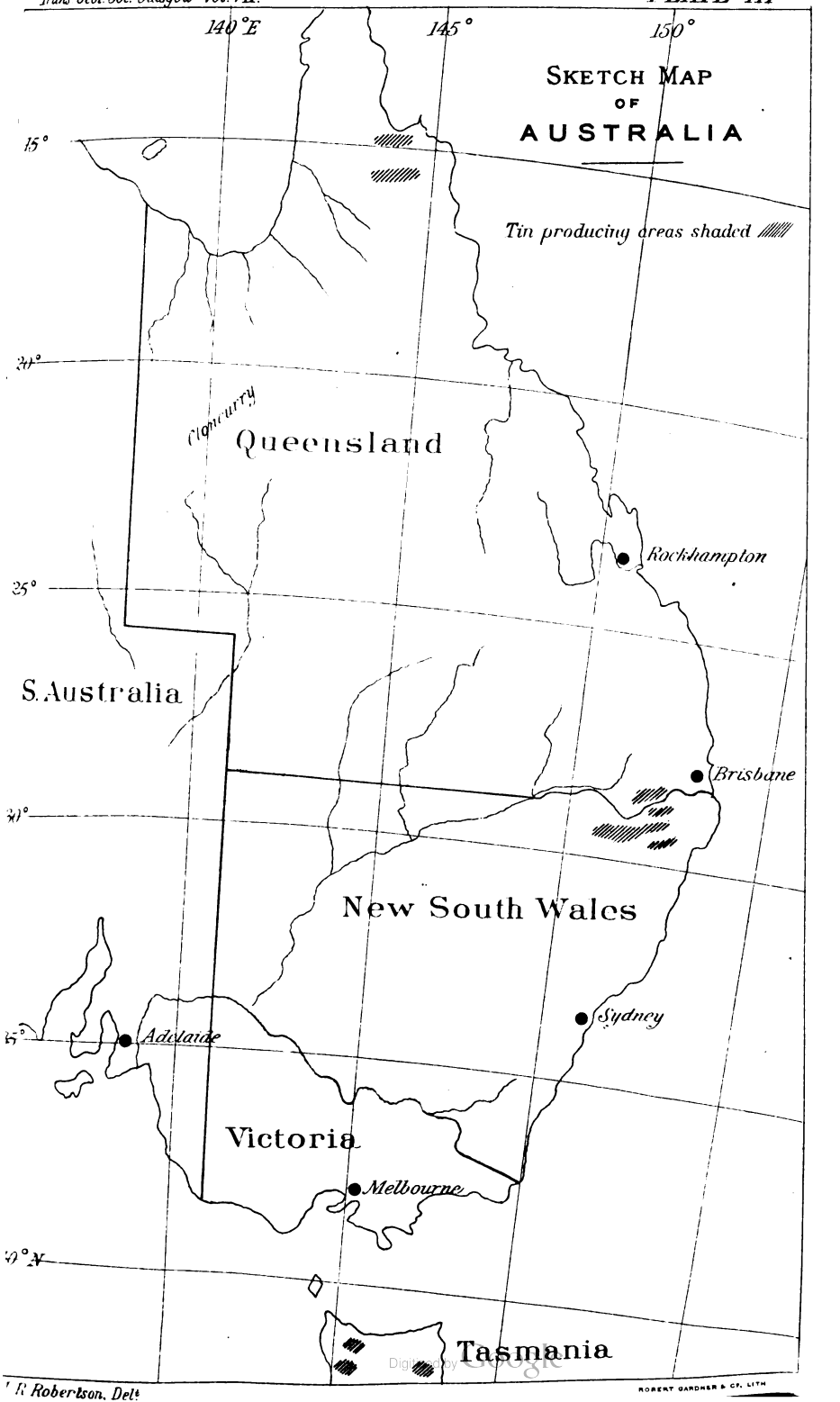


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very prominent collection of which, near Glen Innes, is known as "Stonehenge." The soil which results from the decay of granite is poor, cold, hungry, and infertile, and in this respect Australia is no exception to the general rule.

At various points throughout the granite district, intrusive rocks, basalt in various forms, porphyry, and suchlike, have in comparatively recent times, Tertiary or Post-tertiary, broken through the pre-existing granite. From numerous orifices, vents, and craters, streams of lava, ashes, and volcanic bombs have been poured out over wide tracts of country. These have readily yielded to the effects of climate, the debris being carried by flood-waters, and deposited over the extensive flats and valleys as rich red or black loamy soil. In parts, as around Glen Innes, and stretching 20 miles north and 35 miles west beyond Inverell, the decay of the volcanic rocks has given rise or origin to a soil of a deep chocolate or red colour, due no doubt to the presence of iron. Throughout this, patches of black soil are seen surrounded by red—and *vice versa*—this being entirely owing to the slightly different chemical composition of the rocks, from the decay of which the soil has been derived.

New England is separated from the sea by the high and wild Coast range; to the south and east by the Ben Lomond and Moonbi ranges; to the north by the mountains which in part form the frontier of Queensland; and on the west by the watershed of the Barwan and other tributaries of the Darling, the great river of the interior. Consequent upon its elevation above the sea this district enjoys a truly delightful and salubrious climate, healthy and dry, the air being always clear and bracing, and the sky bright and sunny. It has the climate of Northern Spain or of France. All English cereals, fruits and vegetables, grow to perfection, and to a size scarcely credible to a stranger—the apples of Armidale often reaching the dimensions of a child's head, while at Inverell the Buculla vineyards have become famous. To the north, on the Queensland border, the granite gives place to felsites, porphyries, and highly transmuted rocks. In certain places intrusive dykes specially mineralize patches of country.

## Bismuth.

On the confines of an extensive granite country, such as I have described, and in the immediate vicinity of the irregular line of

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function of transmuted schists, some claims were recently taken up for the purpose of prospecting for Tin. In the course of the prospection several quartz veins or "reefs" were exposed, but although they carried no Tin they were found to contain a variable quantity of coarse gold, and a mineral of which the prospectors had no previous knowledge. It was, from its density, extremely difficult to separate from the precious metal, while some yellow portions of the "gangue" so discoloured the water that the gold was with difficulty distinguished. Further investigation proved that the mineral was not confined to one, but was found in several contiguous quartz reefs, which were exposed on the steep sides of the hill ranges. The country, it may be remarked, is extremely irregular, rough, and difficult to travel over. In course of time, this strange mineral, when analysed by the Government chemist, was pronounced to be Native Bismuth, and the prospectors were duly informed that enormous prices were obtainable for the metal in London. The vision of abundant profits excited their cupidity, and dreams of luxurious mansions and endless earthly honours took possession of the minds of the ignorant and credulous men whose fortune it was to make the discovery, so that fabulous values were attached to their properties. In a word, their reason departed —no uncommon occurrence amongst mining speculators throughout the world.

The entire sale of Bismuth has for years been monopolised by a few London brokers, men no doubt of "light and leading," known as the Bismuth Ring—a close and conservative institution formed for the purpose of controlling the supply and price of Bismuth—and from whom it is impossible to extract any information whatever as to the source of the metal, its occurrence, or the resources of the mines. Under the tender mercies of this admirable institution the original opinions held by the Australian prospectors became considerably modified. There is little doubt, however, that the bulk of the Bismuth of commerce is essentially a bi-product obtained in the treatment of zinc, cobalt, and silver ores, with which metals it is associated, the principal sources of the metal being Saxony, Bolivia, and Mexico. Some Native metal has been obtained from Bolivia, as well as in smaller quantities from Cornwall and South Australia, but it may be considered that, until the discovery of the mines above referred to, Native Bismuth was a mineral curiosity.

Being in the neighbourhood of the discovery, and having been

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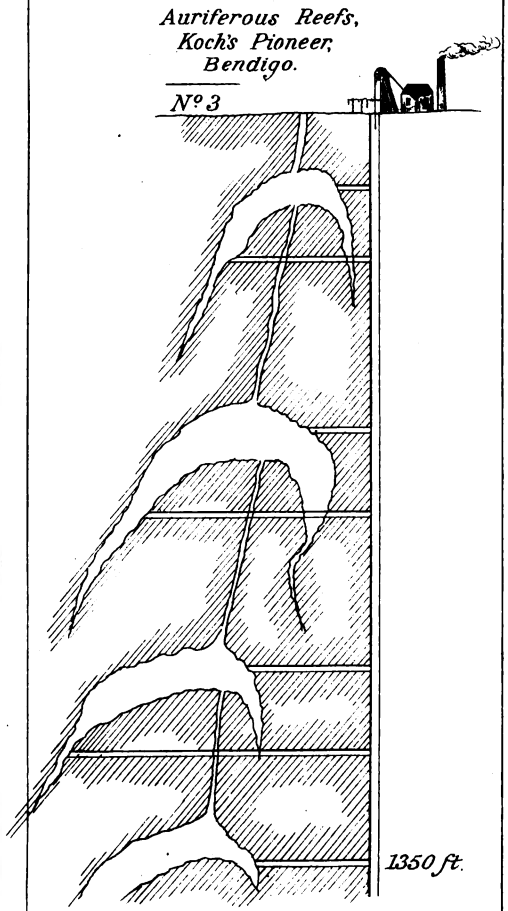


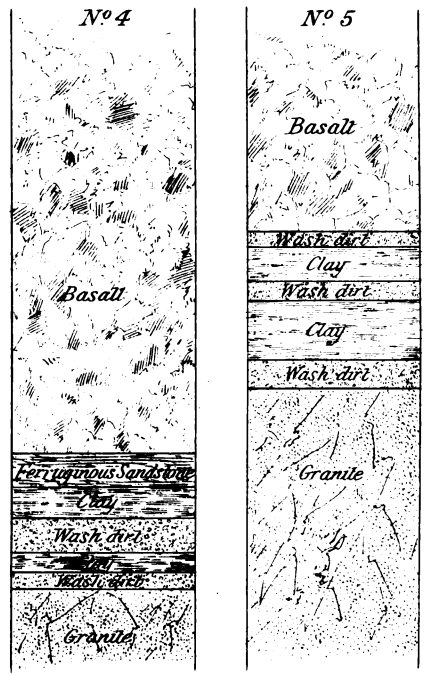


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of use to some of those interested, I was requested to visit the property, a distance of 17 or 18 miles through the bush. As a result of two separate inspections, I am now enabled to give you a short but accurate account of the occurrence of Bismuth in this part of Australia, though in the interests of the proprietors I purposely omit to mention the locality of the mines.

The "country" in which Bismuth is found is composed of ordinary gray granite. On further examination, the reefs in which the mineral occurs are seen to be confined to a small and circumscribed patch where the granite has undergone some alteration. It is soft, partially decomposed, and friable, and is traversed by several "hitches" which displace certain of the lodes. In appearance the granite contiguous to the lodes appears to have lost its felspar and mica to a considerable extent, or these constituents have suffered partial decomposition, and have become charged with a grey or yellow earthy substance to be afterwards noticed, the whole being held together by a body of cellular vitreous quartz. In other words, the "country" is composed of this cellular quartz, the spaces being charged or filled with the yellow earth referred to, and occasionally with needles of Bismuth. A miner would designate it as a "rotten rock." Throughout this, curious irregular deposits—segregations—of "pearly," "sugary," or vitreous quartz occur. These masses assume a peculiar tortuous and strangulated form, and are joined to one another by distinct veins. The reef drawn in sketch No. 1 (Plate IV.), which is a reduced plan of one of these masses or reefs of quartz, varies from 8 to 12 feet wide, and throws out many rounded elbows, knobs, or protuberances, into the friable granite casing, the "underlay" being shown by the arrows. In sketch No. 2. (Plate IV.) I have drawn a section of this through *a*, and from it you will observe that the reef throws out or forms arms, or rather "legs," which partially enclose a mass of "country" having some resemblance to what miners call a "horse." To one unacquainted with Australian mineralogy this condition will be somewhat perplexing. At Bendigo, or Sandhurst, in Victoria, there occurs a remarkable line of auriferous quartz reefs known as "saddlebacks," which form, one above another, in the Silurian slates of that district, and in these reefs may be recognised a condition somewhat analogous to that I have shown in sketch No. 3 (Plate IV.) In other cases the occurrence of the quartz is not so complex. It occurs in true and



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well-defined reefs, which, however, are liable to contract and to expand, and their course is roughly NNW. The substance of this pearly lustrous quartz is broken up by numerous intersecting fissures, and in places well-developed "slickensides" are found. Throughout its substance are masses of large and perfectly-formed smoky quartz crystals, which are most abundant towards the hanging wall.

Native Bismuth is found in, or is carried by, the glassy quartz, but it occurs in various forms, as I shall now proceed to describe. (1) As Native metal it occurs in irregular bunches or nests throughout the substance of the quartz. It is found principally in the fissures referred to, and in perfectly isolated masses or pieces, weighing from ½ lb. to 50 lbs. There is no outward sign to guide one to the *locale* of these nests, but as a rule they are found where a mass of rock has been broken up. I could observe, however, that the largest masses of metal occurred contiguous to the hanging wall, and were most abundant where smoky quartz crystals were found. The metal occurs in a remarkably pure and beautiful condition. Large nests of pure metal are found to fill the open spaces at the intersection of several fissures, throwing out arms into each. Whenever crystals of smoky quartz have formed, Native Bismuth occurs, accurately moulded and set around the crystals, and on removal the exact forms of these are seen. I exhibit a large piece, which I removed from among crystals of quartz, in which every facet is clearly defined, the metal being covered by a thin layer of beautiful yellow oxide. In at least one of the reefs Native Bismuth, in the form of isolated needles, is forced into the substance of the quartz. It is likewise found in small pieces in the casing of the reefs, and, as thin plates or needles, permeating the substance of the casing in the manner just described. (2) The soft casing of the quartz veins is charged with a yellow earth, the colour being due to the presence of Oxide of Bismuth, which has penetrated for a considerable way into the substance of the walls, and seems, with the quartz, to make up their substance. Where the "country" is solid the Oxide may not extend above 8 inches into the casing, but where softer it is found for a thickness of about two feet. Taken as a whole the Oxide forms from 50 per cent. to 30 per cent. of the substance of the walls, and it manifestly forms the most abundant and certain source of Bismuth and can be inexpensively worked, but no atten-

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tion has been paid to the process of recovery. (3) Bismuth occurs in two of the exposed veins as Sulphuret, in characteristic leaden-grey acicular crystals—the quantity, however, being small as compared with that of the Native metal.

I have remarked that Bismuth and crystals of smoky quartz have seemingly an affinity for each other, but I have now to add that in nearly all the lodes large quantities of molybdenite occur. Where Bismuth is most abundant the largest quantities of molybdenite are found, but they are perfectly distinct and separate from each other. Bismuth is almost always found in the fissures or cracks of the quartz reefs, but molybdenite very rarely occurs in this way, being as a rule, though not always, found in little pieces or patches throughout the solid substance of the quartz. These patches are isolated and in parts are so abundant that, as in the specimen before you, they form a very considerable proportion of the whole substance of the reef. In parts molybdic acid in small quantities is found associated with the Oxide of Bismuth, and molybdic ochre is also present. I am not aware of any mine where the same amount of beautifully foliated molybdenite has been found, but here it is thrown aside as valueless. In the neighbourhood of one of the copper mines in South Australia a small quantity of Bismuth for a short time was produced, but at present among mining authorities there both Bismuth and molybdenum are considered as curiosities.

When the London agent of this mining company mooted the fact that he was about to receive a consignment of several tons of Bismuth in large pieces his statement was ridiculed; but on the arrival of the metal the "Ring" became alarmed. Failing to obtain the mine upon their own terms, they resolved not to purchase the ores, or to purchase them at their own price, and, by these means, either to squash the company, or to retain the enormous profits which they had contrived to extract from consumers of the metal, such as manufacturers of Tris-nitrate of Bismuth, for a medicine or for cosmetic preparations in one or other of their many forms. For these, and to a lesser extent for typefounding purposes, the world's demands are at present satisfied by an annual production of 70 tons or so.

So pure is the produce of the mine under review that I have been informed by those who have had extensive experiments made, that a charge of £15 per ton will amply repay the smelter

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for his trouble. Yet that useful public institution—I mean the "Bismuth Ring"—offers a price for the ore that will leave it the trifling profit of about £450 per ton. So far as I can learn this is the only mine of Bismuth in the world. Nowhere else, I believe, is the metal found in the same condition, or to the same extent, or where it can be raised with the same facility, or at the same small expense. The lodes already exposed could, with a small expenditure on wages only, produce sufficient ore to supply all present demands, and at a price which, at the present low market value of Bismuth—6s. 8d. per lb.—would leave a profit of from £500 to £600 per ton, or a gross profit that would more than pay the total cost of the mines in six months! It is a novel occupation, however, and because of this it is correspondingly avoided by those directly interested in metalliferous pursuits. Were it not for its intense novelty, and the trifling quantity of capital required, one might suggest the formation of a "Bismuth Ring" for the Second City of the Empire, to divide with London the enormous profits accruing from the mining, manufacture, and sale of Bismuth.

In the course of extensive explorations in the far north-west of Queensland, I found, in conjunction with alluvial gold in one locality, considerable quantities of Native Bismuth, and in another very much larger quantities of Bismuthine, or Carbonate of Bismuth, a specimen of which I now exhibit. Some uncertainty connected with the hostile tribes of natives in the neighbourhood prevented me from tracing these deposits to their source, but a note of the localities was made for future use.

Without attempting to go into irritating and perhaps superfluous mining or mineralogical details, I have attempted to describe the salient points connected with the occurrence of the valuable metal Bismuth, and I have purposely avoided taking up your time in discussing the probable origin of the metal, because I believe that the origin of metals, generally, must as yet be considered one of the mysteries of creation. I am perfectly aware of the views expressed by distinguished men and original thinkers on this subject, but after all these views are open to the objection that they are but theories, and therefore inappropriate themes to introduce into the present paper.

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## Tin.

About ten years ago, in 1871, a shepherd, I believe, when in one of the principal district towns, accidentally saw some black crystals, which, he was informed, were Tin. Before this time the whole energies of the people had been concentrated on gold. Recognising a resemblance in them to some pebbles he had seen on portions of the sheep-run upon which he was employed, on his return he made a search, and discovered similar crystals in quantities in the bed of a shallow brook called Vegetable Creek, about 28 miles from Glen Innes. The discovery, on being made known, was followed by a rush, and in an incredibly short space of time a very large number of claims had been selected, and many hundreds of men, of all ranks and positions in life, flocked to the field to prospect for Tin. The present township of Vegetable Creek was speedily run up (a colonial township is generally built of wood), a large proportion of the houses being hotels; work began in earnest, and quantities of ore came in from the claims. The colonial digger is generally unmarried, often illiterate, and nearly always thriftless. He leads a bohemian and adventurous life, spends much of his time behind public bars, gambles plenteously, and passes a generally comfortless and debased existence. Many hundreds of rich men were attracted to the new mining industry. Tin mining became popular, and an epidemic of Tin fever supervened.

The Tin of Vegetable Creek is found as stream or alluvial ore, and occurs in the form of Oxide or Casseritite, in the remarkably pure and easily reduced form known as "Ruby ore." When properly dressed it yields from between 74 to 77 per cent. of metal. It was found in greatest abundance in the course of the Creek, which trends towards the west, and meanders through a broad flat, bounded by low ridges of granite. From the bed of this Creek the stream ore was gradually traced into the banks, covered by alluvial deposits of no great depth. As a rule, the ore, being very heavy, was found amongst the gravel immediately above the granite floor, only a very trifling proportion being found mixed with the soil. Topaz, aquamarine, zircon, pleonaste, ruby, amethyst, and even small diamonds, were found in the wash-dirt associated with the stream Tin. Small quantities of "Wood" and "Toad's-eye" Tin have also been found. The stratum which con-

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tains stream ore is generally known by the name of "Wash-dirt." No special tact or ingenuity is required to collect and treat the ore. The surface is first removed and the wash-dirt collected and thrown into oblong wooden boxes or troughs. Into each box a stream of water is directed, the wash-dirt being kept—under the stream—in a state of agitation. The Tin remains towards the head of the box, the earthy materials being carried off, or deposited a few feet further along. The Tin-sand is then subjected to a further washing, and is finally dried on plates of iron held above a fire, and when bagged, is ready for smelting. This is the whole rationale of streaming and collecting the stanniferous deposits of Vegetable Creek and the surrounding districts.

In tracing the wash-dirt into the banks, and along the course of the streams, occasional barren patches of ground were come across, in which the "lead" was completely lost. Numerous prospecting parties (although for the most part working in a perfectly objectless manner) gradually extended the limits of the Tin-field, and additional "leads" or channels were discovered, sometimes proving to be branches of the main "lead," while in other cases they were perfectly distinct channels, trending in an opposite direction. It then became evident to a few of the more intelligent that the metal occupied the beds or courses of ancient streams, only some of which corresponded with the modern channels.

During the opening years of this important industry, the extraordinarily high value of the product, and the facility with which it was worked, enabled very large wages to be given to workmen. As much, I believe, as £36 to £40 per month was demanded and paid in these halcyon days. Enormous wages were made, to be spent in high revelries and improvident conduct. The Creek, in short, in these early days, was a great gambling saloon, a social pandemonium, and rejoiced in a condition of chronic drunkenness. The rich virgin ground was speedily run over in the perfunctory manner so characteristic of the lower class of British workmen. The fall of prices in 1876, and the low rates of succeeding years, precluded the payment of such exorbitant rates for alluvial ore. White labour became discontented, and demanded impossible wages, so that much trouble ensued, and the output speedily diminished. Meantime, the known area of the Tin ground was believed to be pretty well exhausted. Enormous mounds of waste, or refuse heaps, covered the face of the country; and white labour,

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rather than attempt to comprehend the situation, or to yield to the inexorable law of supply and demand, preferred to starve, or to emigrate "to fresh fields and pastures new."

Such was the condition of affairs, when a few Chinamen were introduced. The celestials, ever thrifty and utilitarian, turned their attention to the waste-heaps, which they found to contain such quantities of small Tin, that by working in a systematic and careful manner they could make large wages, at rates very little over £20 per ton. The produce of Tin was at once increased, not so much from streaming new ground, as from recovering ore from the refuse heaps of the improvident whites. An enormous amount of capital has therefore been set free by this class of labour, and an important mining industry has been saved from total annihilation. The Chinese are a sober, law-abiding, careful, saving, and industrious people, and, because of these very attributes, they have become distasteful to publicans, to white working-men, and, I am sorry to say, to a large proportion of the editors of the colonial press. Patient under trials and tribulations, and the lawless barbarity of English-speaking workmen, they generally extended their operations to the virgin ground, introducing such perfect systems of recovering and exhausting the wash-dirt of its metal that the heaps they have turned over may now virtually be considered as waste.

The system which the Chinese introduced (of washing in long faces for a specific object), not only saved much labour, and ensured the perfect recovery of the ore in one operation, but had another result. The "leads" were thoroughly exposed, and were easily followed, and any "leaders" falling into, or joining, the main "lead" were at once discovered, and followed. By these means, the limits of the field have been enormously increased, new areas being discovered almost every day. Tin "leads" have been followed for miles into "country" formerly believed to be barren, and the great resources of the district established.

Hitherto, I have talked of shallow surface-working, but at one or two points a main "lead" of Tin was followed almost at right angles to the original course of the creek, following the deep and tortuous channel of an ancient brook. It dipped under a thick surface, below a cream-coloured clay, pits were sunk, and by underground workings it was traced under 40 feet of surface, and it formed one or two troughs, or basins, containing deposits of

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extraordinary richness. In one of these pits the wash-dirt was followed to the dip until it thinned off and disappeared. Some curiosity was excited in the mind of one of the tributers as to the mode in which it did disappear. He followed it, and traced it forming again under a wedge of reddish rock, afterwards pronounced to be basalt, and ridges of which abound in the district. They extend from the Creek to Inverell, 35 miles west, though they had, up to this time, been considered to be the natural boundaries of all the channels. The importance of this new discovery became apparent, when a very rich "lead" of wash-dirt was traced fairly under the basalt.

To return again to the consideration of the stream ore. In working this, some of the claims were found to contain patches of ore, consisting of coarse crystals of Binoxide of Tin. As a rule, the larger crystals were Ruby ore, which is by far the purest and easiest smelted of all the ores of Tin. The facets of the crystals were in some cases scarcely abraded, and, if broken, the fractures were sharp. In a word, these crystals had not travelled far from the site of their origin. The coarse Tin gives place to finer particles, the grains are rounder and water-worn, and the small grains again give place to almost invisible powder, which has been carried for some distance along the course of the stream. Poor claims are succeeded by others from which very large quantities of coarse Tin are raised. Something like 26,000 tons have been raised from this district alone, and the question arises, from whence came the many thousands of tons of alluvial ore which have been, and still are being taken from the field?

The answer to this is, that this alluvial ore has been derived from lodes of Tin, which intersected the course of the stream; and this, I suppose, can scarcely be gainsaid. Strange to say, however, no lodes sufficient to account for a tithe of the ore have been discovered. Over a very large portion of this extensive Tin-field, the alluvium was thin, and the underlying granite was fairly exposed, but I am not aware of any lodes having been found. In one or two places, traces, or strings of Tin-stone have been sunk upon, in the hope of finding a wide and payable lode, but in every instance they have proved to be unworkable to profit. Intersecting the field in several places, I noticed knife-like projections of a black siliceous "capel," generally considered a favourable indication of ore, specimens of which I exhibit, and on the lower side of the

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"capel" some of the claims contained quantities of coarse Tin, but the source from whence it came has not been traced. I look upon these eruptions of "capel" as marking the course of (and in some places enriching) a lode carrying Tin in irregular pockets or bunches. The "country" or rock, which encloses such pockets, yielding in course of time to the silent and ever-acting forces of nature, operating throughout unnumbered cycles of years, has at length become softened and decomposed, releasing the heavier and insoluble ore, the *debris* of which is being recovered in these days, to minister to the wants and demands of a high civilisation.

For a satisfactory solution of the origin of alluvial or stream Tin, we must prosecute our inquiries at a distance of many miles among the wild and lofty mountain ranges along the Queensland frontiers. These ranges are, in part, composed of low rounded domes of soft coarse granite, and, in part, of cones and steep ranges of porphyritic and transmuted rocks, the splintery outlines of which give a feature to the stern and solemn grandeur of this all but uninhabited region. It is a rough country, elevated many thousand feet above the sea, and enjoys a climate which, for eight months out of twelve, would be considered cold even in Scotland. In proximity to the junction of the granite with these rocks a considerable number of lodes intersect the granite for many miles, and almost every flat and hollow contain more or less stream Tin. The lodes are narrow, and not continuous for great lengths, but their character is to swell out —when the "country" is favourable—and to form bunches of Tin-stone, some of which is beautifully crystallised. Often strings of perfect Tin-crystals cluster round large quartz-crystals, as in the specimen now exhibited. In some instances, along the line of fracture, the granite has become charged or impregnated for many feet with grains of Tin—as another specimen shows. In both of these conditions the Tin is not regularly continuous, but on the contrary is a capricious deposit. Occasionally it will expand into an immense bunch of rich Tin-stone, and as suddenly narrow, or pinch out, scarcely leaving an indication by which it can be followed. The same observation applies to the condition where the granite is in patches charged with Tin.

Now when the "country" that encloses these masses of crystallised Tin decomposes, and ultimately sets free these bunches of ore, they become broken up, scattered by floods of water over the alluvial flats in the vicinity, and deposited according to the size

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and gravity of the pieces. Such, I imagine, is the origin of the productive alluvial Tin deposits of Australia, which in recent years have, to a large extent, supplied the markets of the world. We are quite justified in reasoning from the known to the unknown, and considering the conditions under which lode Tin is found in the district I have just described, as analogous to those which prevailed, in pre-historic times, at Vegetable Creek.

In the alluvial Tin-fields, so often referred to, the veins of Tin have without doubt been capricious, each bunch, or pocket of ore, on being relieved, giving rise to one or more of the prolific patches of wash-dirt I have spoken of. Where the waters were confined the force of the current rolled and carried the ore for considerable distances. It is a remarkable circumstance that in all the extensive districts of Vegetable Creek, Tingha and Inverell, in New South Wales, or Stanthorpe in Queensland, no lode has yet been found so wide and continuous as to be profitably worked. They are all "bunchy," the pockets being separated by long distances of barren and hard "country."

Where so much Ruby ore is found one would suppose that the lodes which do exist in the vicinity would be composed of this variety of ore. I am not, however, aware of any such lode having been found. Here is a large and beautiful specimen of alluvial Ruby ore, yet a lode opened in the immediate vicinity, and from whence we would imagine all the stream ore was derived, contains only jet black crystals. Yet a lode of Ruby Tin does exist somewhere, though its course I could not discover, as I possess a specimen of Tin stone, the Tin being of this description. It was believed to have come from the Oban or Glen Elgin lodes, 40 miles distant. It has occurred to me that the colour of the stream Tin ores of Australia may in part be due to exposure to the climate, and to running water, for untold ages. In all countries the metal derived from stream ores, is of a higher quality, and is more easily refined than that obtained from lodes. I can, from some experience, assure you that this is the case in Tennasserim in the Malayan Peninsula in Lahore, at Perak and Sentangore in the Straits Settlements, and in Banca, as well as in Queensland and in Tasmania.

We shall now return to the consideration of the deep "leads" of ore. I told you that they had been traced under a layer of basalt. When worked by underground roads these "leads" are often extremely difficult to follow, their course being tortuous; but when

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studied narrowly, they present all the aspects of existing rivulets, meandering over an uneven rocky floor. Occasional bars or hard elevations have crossed these ancient stream-beds, and have sometimes turned the water to one side. At other times a narrow channel has been worn in these bars, through which the confined waters gushed or fell, to wash out or form pools, whose size depended on the nature of the rocks and force of the stream. Such "leads" being extremely difficult to follow in underground workings, a number of small pits have been sunk in all directions. Now and then some of these pits strike a Tin "lead" which joins with the main channel, being a tributary to the main "lead." In this way workings from a pit followed one of these branches until it dropped down to the main "lead," a depth of 25 feet. Where a branch joins a main "lead" the latter is always enriched. These "leads," then, mark the site of ancient water-courses which were—as the existing ones are—the channels for carrying off flood-waters; and that their waters were loaded with *debris*, resulting from the decay of the rocks over which they passed, we have evidence. Of the force or volume of the flood-waters of these remote times there is abundant proof in the large quantities of coarse sand, gravel and boulders found in the courses of the streams. When rushing over exposed stanniferous lodes the "country" was gradually softened and removed, and the extent of this erosion is represented by the wash-dirt and Tin ore. Here is a very fair average sample of wash-dirt taken from the face of a deep "lead." Where the current was strong, the wash-dirt and very often all trace of Tin disappears, but where the ancient waters expanded into a large pool, and were permitted to settle, large deposits of Tin were made. (Section No. 4, Plate IV., shows one of the largest of these.) Roughly speaking, a deep "lead" under ordinary conditions will pay to work when the wash contains 1 per cent. of ore, and an ordinary alluvial deposit where it has ½ per cent.

There is good reason to suppose that in the hoary past the climate was very similar to, or perhaps a little warmer than that now prevailing. In the wash-dirt, the wing-coverings of large beetles, and of stick insects, and the shells of snails, as well as remains of other forms of life, are preserved, including varieties of still existing wood. But a time came when the character of the detritus changed. The streams, raised by the accumulations of ages, flowed between wider banks, and the waters carried less sand, and more alumina

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in a finely divided state, than before. A fine, impalpable, white mud, probably derived from the decay of felspar, was gently deposited upon the top of the detritus of sand, gravel, and water-worn grains of Tin. Along with this, wood, leaves, plants, ferns, &c., were floated down, and becoming water-logged, sank, and were covered up by the mud deposited by the waters. These muddy deposits vary from 5 to 10 feet in thickness. Occasionally, under special circumstance, a second layer of gravel, with grains of Tin, is found on the top of the stratum of clay. No. 5 section (Plate IV.) shows a sinking at Tingha, with three beds of wash-dirt superimposed on such deposits. As a rule, the lower or older wash-dirt is always the most productive source of Tin.

This was the condition of these deposits and ancient water-courses, when the subterranean forces, which had been slumbering for ages, were suddenly roused into activity. Over considerable areas of the district numerous volcanic vents poured out enormous quantities of scoriæ, and lava. Hills were formed intersecting the flats; valleys and water-courses became obstructed or completely filled up with streams of lava; the waters sought out new channels; and the physical aspects of the locality became completely changed. When the lava stream poured over, or the hot ashes fell, on the soft and finely comminuted mud, which had been superimposed upon the stanniferous wash, it transformed it into a white burnt substance, such as I now show you. Its laminations became defined, and the impressions of leaves and vegetable matter which it contained were preserved in the beautiful and delicate forms which I have brought for your inspection.

Pits have now been sunk to the stanniferous wash-dirt, through all thicknesses of the basalt, up to 140 feet. In some parts this igneous sheet is tough and hard, in others, shattered, and full of bombs and decomposing volcanic ash. Under it enormous quantities of stanniferous wash-dirt have been preserved under conditions which require capital, skill, and intelligent management for their profitable production. There can be no question that the presence of this basaltic layer has preserved large areas of stanniferous wash-dirt, which but for it might have been removed by floods, and to all intents and purposes lost to mankind. The basalt has, therefore, indefinitely increased the area, and prolonged the existence, of the Tin-mining industry of New South Wales. It contains large quantities of soluble iron, and the facility with which

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this dissolves is evidenced by the extent of the thick, rich, red soils which mark the course of the basaltic flow. On such soils, a luxurious vegetation grows, and now flourishing vineyards and large orchards of luscious fruits have been planted, and promise a new and important industry to the colony. The abounding vegetation of such basaltic soils presents a striking contrast to the cold and struggling plant-life on the surrounding granite. Percolating through the numerous fissures, and along the margins of the ancient channels, the iron has mixed with portions of the sand, pipe-clay, and Tin-sand, forming a hard ferruginous casing which has not unfrequently been mistaken for lode-Tin.

These, I think, are the salient conditions connected with the occurrence of stream and lode-Tin in this, perhaps, the largest Tin-field in Australia. Roughly speaking, this stanniferous district may be said to cover about 600 square miles of area. A small but prolific Tin-field surrounds Stanthorpe on the Queensland frontier, and here, as at Inverell and Tingha on the western margins of the New South Wales district, the life of this lucrative industry is assured by the recent discoveries of deep "leads" under basalt, such as I have just attempted to describe. In the Wilde River and Herberton districts of Northern Queensland, Tin has of late been found in large quantities and of good quality. It has been obtained not only from alluvial deposits, but from lodes which are perfectly workable and rich beyond anything hitherto known. Discoveries of Tin have lately been reported west of the Cloncurry district, on the Gulf of Carpentaria, which I had occasion to inspect. This field is in the north territory of South Australia, and is said to be the largest in the world, but then we must bear in mind that everything found in the colonies is believed—by colonists—to be of its kind the very finest or largest in the world. Colonials love to deal in superlatives, and when comparing their own products with those of other climes, their statements as a rule want precision, and are occasionally unreliable. In Tasmania the alluvial deposits of the east coast, and the extensive and admirably-worked mine of Mount Bischof in the north-west, have been sending large quantities of Tin to market. When I inspected this mine a year ago, it was producing the almost incredible quantity of from 250 to 300 tons of ore per month. To describe, however, the extensive and curious deposits of Mount Bischof mine, would take up too much time at present. Amongst the terrible "horizontal scrub"

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and wild mountain districts, west and south of this mine, the "country" is highly metalliferous, and here within a few months several new stanniferous areas of great promise have been opened up.

In New South Wales the principal Tin-lodes are situated in the wild and sterile mountainous country to the north of the alluvial Tin-fields just described, as well as in the equally mountainous district of Glen Elgin, Glen Innes, and the Coast. There is, I think, ample reason to believe, that the world's wants will be supplied from all of these sources for many years to come. As I have remarked, none of the lodes of Tin discovered in New South Wales or Southern Queensland have as yet been demonstrated to be workable to profit. This is in part due to the irregular, and capricious nature of the lodes themselves, and in part to the want of skill of the miners, and to the high wages demanded by them. It would really appear that the age of hard, and honest work has in the colonies, as at home, ceased to be, and that an age has supervened, in which workmen can earn high wages in return for an insignificant expenditure of labour. At present the whole energies of the working-classes in the colonies seem to be devoted to the exclusion or expulsion of an industrious though an alien race, the Chinese, though the arguments of the white workmen amount to a virtual acknowledgment of the superiority of the yellow race. But what can you make of a class of men who, taken out, probably, within a year or two, as free emigrants, by the generosity of the colonial governments, strenuously oppose the introduction of others of their fellow-creatures, lest the vast solitudes of Australia should become over-populated. Blessed with a truly magnificent climate, the white workman lives improvidently, enjoying the fool's paradise of numerous holidays, and weekly picnics, the consumption of inordinate quantities of tobacco and intoxicating drinks, of looking on work as a plaything, and of believing himself to be a superior being to his employer. In the full enjoyment of manhood suffrage the Australian colonies may at the present moment be considered the paradise (?) of the working-man.

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## No. XVI.—The Geology and Palæontology of Bankend, Bellfield and Coalburn, Lesmahagow. By John R. S. Hunter, LL.D., D.Sc., F.R.Ph.S.E., &c.

[Read 2nd March, 1882.]

There can be few of our members who have not had a geological ramble over this classic locality sometime or other. It lies 3 or 4 miles south-west of the village of Lesmahagow, and can be reached from Brocketsbrae Station, Lesmahagow, or from Douglas Station, on the Muirkirk Railway. Those having antiquarian tastes will be gratified by taking either route, as by the one may be inspected the venerable ruins of Craignethan Castle, and by the other those of Douglas Castle, both immortalized by Sir Walter Scott, the former as Tillietudlem Castle, the latter as Castle Dangerous. The Castle of Douglas, which stands a short distance east of the village of the name, was the place where one of the assassins of Duncan, Earl of Fife, Warden of Scotland, was imprisoned. In the wars waged against the English during the reign of the Edwards, it was held by the English army, under Lord Clifford. Several times surprised by the renowned good Sir James Douglas, it received the name of the "Aiventurus, or Perilous Castle of Douglas." It was at one time demolished by him, but after the last attack it was retained and kept in his possession, as all the surrounding district were loyal adherents of Robert the Bruce. Hume of Godscroft, in 1644, states that the tower built by Lord Clifford then remained, but this ancient structure was unfortunately destroyed by fire in 1755, and now a single ruined tower alone exists to tell the tale. The new Castle is a gorgeous residence, designed by Adam, the eminent architect, but has never been completed in detail.

Numerous other historical places might be pointed out. In and around this neighbourhood were the hiding-places of many of the Covenanters, who had to leave their homes in the "killing times." At Logan House they held some of their meetings, and councils often assembled, the minutes of these interesting gatherings being still preserved. Various relics of byegone times are still in the possession of inhabitants of the district, including guns, pistols, Andrea Ferrara swords, &c.

Some of the tumuli or cairns, the relics of still earlier times, are yet to be found in the district; but alas, they are now nearly

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gone through road-making and improvement of the land for agricultural purposes.

The district of Bankend, Bellfield, and Coalburn, is included in the Carboniferous formation, and is separated from the Auchenheath or Clyde basin proper by a small ridge of Old Red Sandstone on the one side, and on the other by a ridge of the same rock, from the Carboniferous coalfield of Ayrshire. The strata of the district present us with a section which embraces a portion of the Upper Coal measures, taking in the Douglas coalfield as pertaining to this area, down to the upper members of the Silurian strata, and they may be tabulated, as follows, into :—

1. Upper Coal Measures.
2. Millstone grit series.
3. Upper Limestone.
4. Middle Coal Measures.
5. Lower Limestone and Coal.
6. Calciferous Sandstone.
7. Old Red Sandstone.
8. Upper Silurians.

The surface configuration of the district is of an undulating character, and much of the soil is of poor quality. The Boulder-clay is well represented, and travelled boulders from long distances are often met with. Deep ravines which expose the various strata are numerous, and by taking advantage of their natural sections, and of the artificial operations carried on at the various coal and lime works, we have, as regards the palæontological treasures, a range almost unequalled for observation and research. Dislocations of the strata are frequent, some of the faults being of little extent, whilst others are considerable, and cause a vast amount of trouble and expenditure to the various lessees when they are searching for coal and other minerals. The fossiliferous strata are largely exposed, and this has fortunately enabled me to collect such an extended series of organic remains as I have done. The copious development of volcanic rocks in and around the district gives great facilities for the study of the several phenomena connected with them, and whilst we observe their action amongst the adjacent Silurian rocks, and in that of the Old Red Sandstone strata, we also find in the Carboniferous beds striking evidences of great igneous activity.

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The calciferous sandstones are very variable. At one locality, on the Nethan water, about a mile south of Lesmahagow, they are entirely wanting, and the Carboniferous limestone series is seen resting upon the Old Red Sandstone, whilst at Bankend and Douglas they are composed of thick grey gritty sandstones, with sandy clay and marly beds. They thin out to the north of Lesmahagow, while north and east of Glenbuck they show a type between this and that of the Ayrshire coalfield, at Middlefield, where they are well represented, the series being composed of red, blue, and green clays, with numerous cementstone bands. They formerly were included amongst the Old Red Sandstone rocks, but are now considered to be the basement beds of the Carboniferous system. On Nethan water, at Craighead, a white nodular limestone, a few feet in thickness, is observed. It is also found at Bankend in Nethan water, at the foot of Pockmuir burn, then again at Cumberhead, where it has been worked for agricultural purposes, and again when passing South Bankendhill to Craigenrigg it is well seen, being intersected by a dyke of porphyry. It is next seen at Gillburn, where it nearly comes in contact with the Old Red Sandstone, and again on the sloping ground of the Hagshaw hills, where it has been wrought to some extent. No organic remains have as yet been observed in these rocks. Above this nodular limestone, which is most probably a cornstone, is a whitish-yellow sandstone, very variable both in its bedding and thickness. It is seen at Gillburn or Monkswater, where some of the bands contain obscure plant remains, and is well developed in Nethan Water, at High Stockbriggs, and Hill House. Above these rocks a thin series of shales makes its appearance along with a thin stratum of coal, &c.

The exact horizon between the Carboniferous limestone and the calciferous sandstone as developed in Scotland, is often an extremely difficult problem to define, there being here no great body of limestone at the base of the group, as in other parts of the world, to guide us. We can therefore only look to the fossil contents of the various strata to show that their position is identical with the Carboniferous limestone of other countries. What occasioned the splitting up of the strata into so many beds of such different substances is not easily explainable, unless on the theory that they were formed over shallow-water tracts of sea and lake bottoms, and that they had undergone numerous upheavals and depressions through volcanic agency.



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A section of these strata which I have prepared [see page 155] denotes a succession of great changes, for coalbeds are succeeded by sandstones, shales, limestones, &c., and many alternations of the same beds occur in this and adjoining localities. The strata, being formed at one time under fresh-water and at another under marine conditions, present us in the one case with fresh-water, brackish-water, or estuarine species, whilst the other shows us abundance of corals and brachiopods, undoubted tenants of the sea. From the depth of the section—134 fathoms 9½ inches—there can be no doubt that frequent oscillations of level produced all the various alternations of shales, sandstones, coals, fireclays, limestones, and ironstones. The section shows that there were numerous marshes at this remote period, hence the blackband ironstones with their entombed fresh-water or brackish-water organisms; also deep and shallow-water seas, with an abundance of marine life; again that there were areas lying high and dry, and producing an abundance of vegetation which went to form the various coal seams; and then a transition from a period of great verdure to an apparent absence of all life. The specific identity of the various forms of life in the Carboniferous series, widely as it has been observed in various parts of the world, gives unmistakeable evidence that a general uniformity of temperature existed during the continuance of these various conditions.

The total thickness of the limestone series from top to bottom of the section is 74 feet. Some of the lower and upper beds have been extensively wrought by pits and open-casts, for the use of various ironworks in the West of Scotland, as well as for building and other occasional purposes. They vary in quality and thickness at various localities, some being calmy or argillaceous, and therefore quite unfit for any useful purpose, whilst others are of first-rate quality. The area yet to be excavated will last for centuries, the field being of vast extent, and of great commercial value.

I purpose now to enter into the palæontological details, and to show the treasures that have been gathered from this fertile group of strata. It will be found in the following list that I classify all the organisms found above the Index or Bellfield limestone, as those from the Upper Limestone; those from this point downwards to top of No. 5 limestone of the section, as from the

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Middle Coal Measures; and those from this point downwards as from the Lower Limestone. My sole reason for this arrangement is simply that the organisms in the various horizons have not been as yet exhaustively worked out. To complete the list will, however, be my endeavour, as I hope to be able to bring before your Society in future papers; for a proper classification of the fossil remains of each district, correlating the various horizons as far as possible, should be the object of all true workers in every such comparatively untrodden field of enquiry.

It will be seen that some of the horizons are extremely rich in organic remains. Some of these fossils are unquestionably rare, others are extremely common, and, probably, not a few may turn out new to science.

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## *FOSSILS OF THE LOWER LIMESTONE.*

### PROTOZOA.

#### FORAMINIFERA.

1. *Archædiscus Karreri*, Brady.
2. *Climacammina antiqua*, Brady.
3. *Endothyra Bowmanni*, Phill.
4. ,, *globolus*, D'Eichw.
5. ,, *macella*, Brady.
6. ,, *ornata*, Brady.
7. ,, *radiata*, Brady.
8. ,, *subtilissima*, Brady.
9. *Textularia eximiæ*, D'Eichw.
10. ,, *gibbosa*, D'Orb.
11. *Trochammina incerta*, D'Orb.
12. *Valvulina bulloides*, Brady.
13. ,, *decurrens*, Brady.
14. ,, *palæotrochus*, Ehrenb.
15. ,, *Youngi*, Brady.
16. ,, ,, var. *contraria*, Brady.

### PROTOZOA.

#### SPONGIDÆ.

1. *Hyalonema parallelum*, M'Coy.

### HYDROZOA (?).

1. *Palæocoryne radiatum*, Dunc. & Jenk.
2. *Palæocoryne Scoticum*, Dunc. & Jenk.

### ACTINOZOA.

1. *Alveolites depressa*, Flem.
2. *Amplexus coralloides*, Sow.
3. ,, *Henslowi*, Milne Edw.
4. ,, *spinosus*, De Kon.
5. *Aulophyllum fungites*, Milne Edw.
6. *Campophyllum Murchisoni*, Milne Edw.
7. *Cladochonus Bechei*, Milne Edw.
8. *Clisiophyllum bipartitum*, M'Coy.
9. ,, *Keyserlingi*, M'Coy.
10. *Cyathaxonia cornu*, Michelin.
11. *Cyathophyllum pseudo-vermiculare*, M'Coy.
12. *Cyclophyllum Bowerbankii*, D. & T.
13. ,, *fungites*, D. & T.
14. *Dibunophyllum M'Chesneyi*, T. & N.
15. *Fistulipora minor*, M'Coy.
16. *Favosites parasitica*, Phill.
17. *Heterophyllia angulata*, Dunc.
18. ,, *granulata*, Dunc.

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19. *Heterophyllia M'Coyi*, Dunc.
20. ,, *mirabilis*, Dunc.
21. ,, *Sedgwicki*, Dunc.
22. *Koninckophyllum interruptum*, T. & N.
23. ,, *Lindströmi*, T. & N.
24. ,, *magnificum*, T. & N.
25. ,, *retiforme*, T. & N.
26. *Lithostrotion junceum*, Flem.
27. ,, *irregulare*, Phill.
28. *Lonsdaleia rugosa*, M'Coy.
29. *Michelinia tenuisepta*, Phill.
30. *Rhodophyllum simplex*, Thoms.
31. *Stenopora* (?) *Urei*, Flem.
32. *Syringopora reticulata*, Goldf.
33. *Zaphrentis cylindrica*, Scouler.
34. ,, *Griffithi*, Milne Edw.
35. ,, *nodulosa*, Phill.
36. ,, *spinulosa*, Milne Edw.

## ECHINODERMATA.

1. *Archæocidaris Scotica*, J. Young.
2. ,, *Urei*, Flem.
3. *Hydreionocrinus globularis*, DeKon.
4. *Platycrinus trigintidactylus*, Austin
5. *Poteriocrinus crassus*, Miller.
6. ,, *M'Coyanus*, De Kon.
7. *Rhodocrinus uniarticulatus*, De Kon.

## ANNELIDA.

1. *Ortonia carbonaria*, J. Young.
2. *Spirorbis ambiguus*, Flem.
3. *Spirorbis caperatus*, M'Coy.
4. ,, sp. (?)

## CRUSTACEA.

### OSTRACODA.

1. *Bairdia brevis*, Jones & Kirkby.
2. ,, *curta*, M'Coy.
3. ,, *Hisingeri*, Münst.
4. ,, *plebeia*, Reuss.
5. ,, *submucronata*, J. & K.
6. ,, *subelongata*, J. & K.
7. *Beyrichia bituberculata*, M'Coy.
8. *Cypridina primæva*, M'Coy.
9. *Cythere cornigera*. J. & K.
10. ,, *reticulosa*, J. & K.
11. *Cythere ventricornis*, J. & K.
12. *Kirkbya annectans*, J. & K.
13. ,, *costata*, M'Coy.
14. ,, *oblonga*, J. & K.
15. ,, *Permiana*, Jones.
16. ,, *spinosa*, J. & K.
17. ,, *umbonata*, D'Eichw.
18. ,, *Urei*, Jones.
19. *Leperditia Armstrongiana*, J. & K.
20. ,, *Okeni*, Münst.

## CRUSTACEA.

### TRILOBITA.

1. *Griffithides mesotuberculatus*, M'Coy.

## POLYZOA.

1. *Ceramopora megastoma*, M'Coy.
2. *Ceriopora interporosa*, Phill.
3. *Fenestella multiporata*, M'Coy.
4. *Goniocladia*, sp.
5. *Glauconome elegans*, Y. & Y.
6. ,, *laxa*, Y & Y.
7. ,, *recticarinata*, J. Young
8. ,, *retroflexa*, Y. & Y.
9. ,, *robusta*, Y. & Y.
10. ,, *stellipora*, Y. & Y.
11. *Hyphasmopora Buskii*, Ether.
12. *Rhabdomeson gracile*, Phill.
13. ,, *rhombiferum*, Phill.
14. *Sulcoretipora parallela*, Phill.
15. ,, *raricosta*, M'Coy.
16. ,, *Robertsoni*, Y. & Y.
17. *Synocladia* (?) *carbonaria*, Ether.
18. *Thamniscus Rankini*, Y. & Y.
19. *Vincularia approximata*, D'Eichw.
20. ,, (?) *megastoma*, M'Coy.

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## BRACHIOPODA.

1. *Athyris ambigua*, Sow.
2. ,, *pisum*, Dav.
3. ,, *plano-sulcata*, Phill.
4. ,, *Royssii*, Léveille.
5. *Camarophoria globulina*, Phill.
6. *Chonetes Buchiana*, De Kon.
7. ,, *Laguessiana*, De Kon.
8. ,, *polita*, M'Coy.
9. *Crania quadrata*, M'Coy.
10. *Discina nitida*, Phill.
11. *Lingula mytiloides*, Sow.
12. ,, *squamiformis*, Phill.
13. *Orthis Michelini*, Léveille.
14. ,, *resupinata*, Martin.
15. *Productus aculeatus*, Martin.
16. ,, *costatus*, J. de C. Sow.
17. ,, *cora*, D'Orb.
18. ,, *Deshayesianus*, De Kon.
19. ,, *fimbriatus*, J. de C. Sow.
20. ,, *giganteus*, Mart.
21. ,, *latissimus*, J. de C. Sow.
22. ,, *longispinus*, Sow.
23. ,, *Griffithianus*, De Kon.
24. ,, *punctatus*, Mart.
25. ,, ,, var. *elegans*, M'Coy.
26. *Productus pustulosus* (?). Phill.
27. ,, *scabriculus*, Mart.
28. ,, *semireticulatus*, Mart.
29. ,, *sinuatus*, De Kon.
30. ,, *spinulosus*, Sow.
31. ,, *Youngianus*, Dav.
32. *Retzia radialis*, Phill.
33. *Rhynchonella pleurodon*, Phill.
34. ,, *pugnus*, Mart.
35. *Rhynchopora Youngii*, Dav.
36. *Spirifera Carlukensis*, Dav.
37. ,, *duplicicosta*, Phill.
38. ,, *glabra*, Mart.
39. ,, *lineata*, Mart.
40. ,, *ovalis*, Phill.
41. ,, *striatus* (?), Mart.
42. ,, *trigonalis*, Mart.
43. ,, *Urei*, Flem.
44. *Spiriferina cristata*, Sow.
45. ,, *insculpta*, Phill.
46. ,, *laminosa*, M'Coy.
47. *Streptorhynchus crenistria*, Phill.
48. *Terebratula hastata*, Sow.
49. ,, ,, var. *Gillingensis*, Dav.
50. ,, ,, var. *sacculus*, Mart.

## LAMELLIBRANCHIATA.

### MONOMYARIA.

1. *Aviculopecten cœlatus*, M'Coy.
2. ,, *fimbriatus*, Phill.
3. ,, *Knockonniensis*, M'Coy.
4. *Pinna flabelliformis*, Mart.
5. *Pteronites persulcatus*, M'Coy.

## LAMELLIBRANCHIATA.

### DIMYARIA.

1. *Conocardium aliforme*, Sow.
2. ,, *armatum*, Phill.
3. *Edmondia Egertoni*, M'Coy.
4. ,, *rudis*, M'Coy.
5. ,, *sulcata*, Phill.
6. *Leda attenuata*, Flem.
7. *Modiola elongata*, Phill.
8. ,, *lithodomoides*, Ether., jun.
9. *Modiola lingualis*, Phill.
10. *Myalina crassa*, Flem.
11. ,, *Verneuilii*, M'Coy.
12. *Nucula gibbosa*, Flem.
13. *Sanguinolites iridinoides*, M'Coy.
14. ,, *plicatus*, Portlock.
15. *Solenomya primæva*, Phill.

## GASTEROPODA.

1. *Dentalium ingens*, De Kon.
2. ,, *priscum*, Goldfuss.
3. ,, *Scoticum*, J. Young.
4. *Eulima Phillipsiana*, De Kon.
5. *Euomphalus carbonarius*, Sow.
6. ,, *pentangulatus*, Sow.
7. *Lacuna antigua*, M'Coy.
8. *Loxonema Lefebvrei*, Léveille.
9. ,, *rugifera*, Phill.
10. ,, *scalaroidea*, Phill.
11. *Macrocheilus acutus*, Sow.
12. ,, *Michotianus*, De Kon.
13. *Murchisonia quadricarinata*, M'Coy
14. *Naticopsis elliptica*, Phill.
15. ,, *elongata*, Phill.
16. ,, *plicistria*, Phill.
17. *Pleurotomaria Griffithi*, M'Coy.
18. ,, *Yvanii*, Léveille.
19. *Platyceras neritoides*, Phill.
20. *Trochus lepidus*, De Kon.

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### HETEROPODA.

1. *Bellerophon cornu-arietis*, Sow.
2. ,, *decussatus*, Flem.
3. ,, *Dumontii*, D'Orb.
4. *Bellerophon Urei*, Flem.
5. *Porcellia armata*, De Verneuil.

### PTEROPODA.

1. *Conularia sulcata*, Miller.

### CEPHALOPODA.

1. *Cyrtoceras rugosum*, Flem.
2. ,, *unguis*, Phill.
3. *Goniatites Looneyi*, Phill.
4. *Nautilus ingens*, Mart.
5. *Nautilus Léveilleanus*, De Kon.
6. *Orthoceras lineale*, De Kon.
7. ,, *undatum*, Flem.
8. *Poterioceras fusiforme*, Sow.

### PISCES.

1. *Cochliodus acutus*, Agassiz.
2. ,, *contortus*, Agassiz.
3. ,, *magnus*, Agassiz.
4. ,, *striatus*, Agassiz.
5. *Helodus lævissimus*, Agassiz.
6. ,, *mammillaris*, Agassiz.
7. *Petalodus Hastingsiæ*, Owen.
8. *Pœcilodus aliformis*, Agassiz.
9. *Psammodus porosus*, Agassiz.
10. ,, *rugosus*, Agassiz.
11. *Rhizodopsis granulatus*, Agassiz.

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## *FOSSILS OF THE MIDDLE COAL MEASURES.*

### LAMELLIBRANCHIATA.

#### DIMYARIA.

1. *Anthracoptera carinata*, Sow.
2. ,, *modiolaris*, Sow.
3. *Anthracoptera quadrata*, Sow.
4. *Anthracosia acuta*, Sow.

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## *FOSSILS OF THE UPPER LIMESTONE.*

### PROTOZOA.

#### FORAMINIFERA.

1. *Valvulina decurrens*, Brady.
2. *Valvulina palæotrochus*, var. *compressa*, Ehrenberg.

### HYDROZOA (?).

1. *Palæocoryne Scoticum*, Duncan.

### ACTINOZOA.

1. *Amplexus coralloides*, Sow.
2. *Favosites parasitica*, Phill.
3. *Stenopora* (?) *Urei*, Flem.
4. *Zaphrentis patula*, Mich.
5. ,, *Enniskilleni*, Milne Edw.

### ECHINODERMATA.

1. *Archæocidaris Urei*, Flem.
2. *Hydreionocrinus globularis*, De Kon.
3. *Platycrinus trigintidactylus*, Austin.
4. *Poteriocrinus crassus*, Miller.
5. *Rhodocrinus uniarticulatus*, De Kon.

### ANNELIDA.

1. *Serpulites membranaceus*, M'Coy.
2. *Spirorbis caperatus*, M'Coy.

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## CRUSTACEA.

### OSTRACODA.

1. *Bairdia plebeia*, J. & K.
2. ,, *Hisingeri*, Münst.
3. *Bairdia submucronata*, J. & K.

## POLYZOA.

1. *Ceramopora megastoma*, M'Coy.
2. *Ceriopora interporosa*, Phill.

## BRACHIOPODA.

1. *Athyris ambigua*, Sow.
2. ,, *plano-sulcata*, Phill.
3. ,, *Royssii*, Léveille.
4. *Chonetes Laguessiana*, De Kon.
5. *Crania quadrata*, M'Coy.
6. *Discina nitida*, Phill.
7. *Lingula mytiloides*, Sow.
8. ,, *squamiformis*, Phill.
9. *Orthis resupinata*, Mart.
10. *Productus aculeatus*, Mart.
11. ,, *costatus*, J. de C. Sow.
12. ,, *Griffithi*, De Kon.
13. ,, *latissimus*, J. de C. Sow.
14. ,, *longispinus*, Sow.
15. ,, *punctatus*, Mart.
16. *Productus scabriculus*, Mart.
17. ,, *semireticulatus*, Mart.
18. ,, *sinuatus*, De Kon.
19. ,, *Youngianus*, Dav.
20. *Retzia radialis*, Phill.
21. *Rhynchonella pleurodon*, Phill.
22. *Spirifera Carlukensis*, Dav.
23. ,, *duplicicosta*, Phill.
24. ,, *lineata*, Mart.
25. ,, *trigonalis*, Mart.
26. ,, *Urei*, Flem.
27. *Spiriferina cristata*, Sow.
28. ,, *laminosa*, M'Coy.
29. *Streptorhynchus crenistria*, Phill.
30. *Terebratula hastata*, Sow.

## LAMELLIBRANCHIATA.

### MONOMYARIA.

1. *Aviculopecten arenosus*, Phill.
2. ,, *interstitialis*, Phill.
3. *Aviculopecten simplex*, De Kon.

## LAMELLIBRANCHIATA.

### DIMYARIA.

1. *Arca Lacordairеana*, De Kon.
2. *Axinus axiniformis*, Phill.
3. ,, *carbonarius*, Portl.
4. ,, *deltoideus*, Phill.
5. *Cardiomorpha oblonga*, Sow.
6. *Cypricardia crebricostata*, Armstrong.
7. ,, *glabrata*, Phill.
8. ,, *quadrata*, M'Coy.
9. ,, *rhombea*, Phill.
10. *Edmondia Egertoni*, M'Coy.
11. ,, *rudis*, M'Coy.
12. *Leda attenuata*, Flem.
13. ,, *birostrata*, M'Coy.
14. ,, *clavata*, M'Coy.
15. ,, *longirostris*, M'Coy.
16. *Leda intermedia*, Ether. jun.
17. *Myacites sulcata*, Flem.
18. *Myalina crassa*, Flem.
19. ,, *Verneuilii*, M'Coy.
20. *Mytilus comptus*, M'Coy.
21. *Nucula acuta*, Sow.
22. ,, *gibbosa*, Flem.
23. ,, *lævirostrum*, Portl.
24. ,, *lineata*, Phill.
25. ,, *luciniformis*, Phill.
26. *Pteronites persulcatus*, M'Coy.
27. *Sanguinolites plicatus*, Portl.
28. ,, *iridinoides*, M'Coy.
29. ,, *tricostatus*, Portl.
30. *Solenopsis minor*, M'Coy.
31. *Venus elliptica*, Phill.

## GASTEROPODA.

1. *Dentalium inornatum*, M'Coy.
2. ,, *priscum*, Goldf.
3. *Euomphalus carbonarius*, Sow.
4. ,, *Dionysii*, Goldf.
5. ,, *pentangulatus*, Sow.
6. *Lacuna antiqua*, M'Coy.
7. *Loxonema brevis*, M'Coy.
8. ,, *curvilinea*, Phill.
9. ,, *Lefebvrei*, Léveille.
10. ,, *rugifera*, Phill.
11. ,, *scalaroidea*, Phill.
12. *Macrocheilus acutus*, Sow.

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13. *Macrocheilus fusiformis*, Sow.
14. ,, *imbricatus*, Sow.
15. ,, *Michotianus*, De Kon.
16. *Murchisonia striatula*, De Kon.
17. ,, *quadricarinata*, M'Coy.
18. *Naticopsis canaliculata*, M'Coy.
19. ,, *elliptica*, Phill.
20. ,, *elongata*, Phill.
21. ,, *lirata*, Phill.
22. ,, *Omaliana*, De Kon.
23. ,, *plicistria*, Phill.
24. *Naticopsis variata*, Phill.
25. *Platyceras conica*, Phill.
26. ,, *neritoides*, Phill.
27. ,, *vetustus*, Sow.
28. *Pleurotomaria Frenoyana*, De Kon.
29. ,, *monilifera*, Phill.
30. ,, *striata*, Sow.
31. ,, *Yvanii*, Léveille.
32. *Trochus biserratus*, Phill.
33. ,, *lepidus*, De Kon.
34. *Turbo biserialis*, Phill.

## HETEROPODA.

1. *Bellerophon decussatus*, Flem.
2. ,, *Duchastelli*, Léveille.
3. ,, *Dumontii*, D'Orb.
4. ,, *Léveilleanus*, De Kon.
5. *Bellerophon Oldhamii*, Portl.
6. ,, *Urei*, Flem.
7. *Porcellia armata*, De Verneuil.

## PTEROPODA.

1. *Conularia quadrisulcata*, Sow.

## CEPHALOPODA.

1. *Actinoceras giganteum*, Sow.
2. *Cyrtoceras Gesneri*, Mart.
3. ,, *unguis*, Phill.
4. *Goniatites excavatus*, Phill.
5. ,, *Looneyi*, Phill.
6. ,, *striolatus*, Phill.
7. ,, *vesica*, Phill.
8. *Nautilus biangulatus*, Sow.
9. *Nautilus inyens*, Mart.
10. ,, *globatus*, Sow.
11. ,, *quadratus*, Flem.
12. ,, *tuberosus*, M'Coy.
13. *Orthoceras attenuatum*, Flem.
14. ,, *subcentrale*, De Kon.
15. ,, *undatum*, Flem.
16. *Poterioceras fusiforme*, Sow.

## PISCES.

1. *Cochliodus magnus*, Ag.
2. *Gyracanthus formosus*, Ag.
3. *Petalodus Hastingsiæ*, Owen.
4. *Rhizodus Hibberti*, Ag.

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Table of the Classes, Genera, and Species, found in the Lower Limestone, Middle Coal Measures, and Upper Limestone, of Bankend, Bellfield, and Coalburn, Lesmahagow.

| | CLASSES. | GENERA. | SPECIES. |
|---|---|---|---|
| LOWER LIMESTONE. | 1. PROTOZOA(FORAMINIFERA), | 6 | 16 |
| | ,, (SPONGIDAE), - | 1 | 1 |
| | 2. HYDROZOA, - - - | 1 | 2 |
| | 3. ACTINOZOA, - - - | 21 | 36 |
| | 4. ECHINODERMATA, - - | 5 | 7 |
| | 5. ANNELIDA, - - - | 2 | 4 |
| | 6. CRUSTACEA (OSTRACODA), | 5 | 20 |
| | ,, (TRILOBITA), - | 1 | 1 |
| | 7. POLYZOA, - - - | 11 | 20 |
| | 8. BRACHIOPODA, - - | 15 | 50 |
| | 9. LAMELLIBRANCHIATA— | | |
| | ,, (MONOMYARIA), | 3 | 5 |
| | ,, (DIMYARIA), - | 8 | 20 |
| | 10. GASTEROPODA, - - | 11 | 20 |
| | 11. HETEROPODA, - - - | 2 | 5 |
| | 12. PTEROPODA, - - - | 1 | 1 |
| | 13. CEPHALOPODA, - - | 5 | 8 |
| | 14. PISCES, - - - - | 6 | 11 |
| | TOTAL, | 104 | 227 |
| MIDDLE COAL MEASURES. | 1. LAMELLIBRANCHIATA— | | |
| | (DIMYARIA), | 2 | 4 |
| | TOTAL, | 2 | 4 |
| UPPER LIMESTONE. | 1. PROTOZOA(FORAMINIFERA), | 1 | 2 |
| | 2. HYDROZOA, - - - | 1 | 1 |
| | 3. ACTINOZOA, - - - | 4 | 5 |
| | 4. ECHINODERMATA, - - | 5 | 5 |
| | 5. ANNELIDA, - - - | 2 | 2 |
| | 6. CRUSTACEA (OSTRACODA), | 1 | 3 |
| | 7. POLYZOA, - - - | 2 | 2 |
| | 8. BRACHIOPODA, - - | 13 | 30 |
| | 9. LAMELLIBRANCHIATA— | | |
| | ,, (MONOMYARIA), | 1 | 3 |
| | ,, (DIMYARIA,), - | 14 | 31 |
| | 10. GASTEROPODA, - - | 11 | 34 |
| | 11. HETEROPODA, - - - | 2 | 7 |
| | 12. PTEROPODA, - - - | 1 | 1 |
| | 13. CEPHALOPODA, - - | 6 | 16 |
| | 14. PISCES, - - - - | 4 | 4 |
| | TOTAL, | 68 | 146 |

In the foregoing comparative table it will be found that there are one hundred and four genera, and two hundred and twenty-seven species, in the Lower Limestone; in the Middle Coal Measures, two genera and four species; in the Upper Limestone, sixty-eight genera and one hundred and forty-six species. The

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flora of the various periods are not included, as I have not as yet done much in this portion of the field.

I intended before concluding to have made a few remarks concerning some of the rarer forms, but I find I have already taken up too much of your time, and I will therefore draw my paper to a conclusion with a few general observations. The most prominent forms of life which give a special character to the Lower Limestone fauna are found amongst the cyathophylloid corals. Amongst the strata of the Upper Limestone group, the corals and brachiopods lose their prominence both in numbers and species, as we find in the Lower Limestone that the corals amount to thirty-six, and the brachiopods to fifty species, whilst in the Upper Limestone the numbers are reduced to five species in the one case, and to thirty species in the other. This gives unmistakable evidence that these groups were fast dying out, and giving place to other forms of life more suitable to the situation, the causes being probably changes of climate, and temperature of the water. During the deposition of the Lower Limestone, this district must have been a coral-growing part of the sea, as many thousand specimens have been collected from a very small area, and bearing evidence also that the sea was comparatively shallow, for it is a well authenticated fact that corals grow and form limestone only when they are within the influence of the waves, but where the water also is free from muddy sediments. In the Lower Limestone we find shells still shewing traces of the colour bands, which proves that there was beauty and design of colouring in Carboniferous, as well as in recent, times.

In the preceding remarks I have endeavoured to give a correct list of the fauna of the separate horizons as far as possible, but much yet requires to be done before a thorough identification is arrived at. We require a Davidson to work out the various genera and species of other Scottish groups which have been collected by various members of our Society and preserved in their magnificent cabinets. Certain forms have been provisionally allocated to genera and species, and a more critical examination may yet prove them to be distinct, whilst a few may even turn out to be new to the Carboniferous strata of Scotland.

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# VERTICAL SECTION OF CARBONIFEROUS STRATA,

## BANKEND, BELLFIELD, AND COALBURN, LESMAHAGOW.

| No. | | Fath. | Ft. | In. |
|---|---|---|---|---|
| 1. | Limestone, - - - - - - Fossil remains, | 1 | 0 | 0 |
| | Shale and laminated Sandstone, - do. | 9 | 0 | 0 |
| 2. | Limestone, - - - - - - do. | 0 | 4 | 0 |
| | Fireclay, - - - - - - - - - | 2 | 1 | 0 |
| | Sandstone, - - - - - - - - - | 6 | 2 | 0 |
| | Shale, - - - - - - - - - - | 0 | 5 | 0 |
| 3. | Limestone, - - - - - - Fossil remains, | 0 | 4 | 5 |
| | Fireclay, - - - - - - - - - | 2 | 4 | 0 |
| | Shale and laminated Sandstone, - - - - | 8 | 5 | 0 |
| | Sandstone, - - - - - - - - - | 7 | 2 | 0 |
| | Calcareous Shale, - - - - Fossil remains, | 3 | 4 | 0 |
| 4. | *Limestone, - - - - - do. | 1 | 2 | 0 |
| | Shale, - - - - - - - - - - | 0 | 3 | 0 |
| | Coal, - - - - - - - - - - | 0 | 0 | 4 |
| | Fireclay, - - - - - - - - - | 1 | 1 | 0 |
| | Coal, - - - - - - - - - - | 0 | 1 | 8 |
| | Shale and Fireclay, - - - - - - - | 4 | 4 | 0 |
| | †Coal, - - - - - - - - - | 0 | 2 | 10 |
| | Fireclay, - - - - - - - - - | 0 | 3 | 0 |
| | Sandstone, laminated, - - - - - - - | 0 | 4 | 0 |
| | Sandstone, - - - - - - - - - | 0 | 4 | 6 |
| | Shale, - - - - - - - - - - | 0 | 0 | 1 |
| | Sandstone, - - - - - - - - - | 0 | 0 | 9 |
| | ‡Coal, - - - - - - - - - - | 0 | 3 | 10 |
| | Fireclay, - - - - - - - - - | 0 | 3 | 0 |
| | §Coal, - - - - - - - - - - | 0 | 2 | 9 |
| | Shale, - - - - - - - - - - | 0 | 0 | 6 |
| | Coal, - - - - - - - - - - | 0 | 0 | 6 |
| | Shale, - - - - - - - - - - | 1 | 0 | 0 |
| | Sandstone, - - - - - - - - - | 0 | 1 | 9 |
| | Shale, - - - - - - - - - - | 0 | 3 | 11 |
| | Coal, - - - - - - - - - - | 0 | 1 | 2 |
| | Sandstone, - - - - - - - - - | 0 | 5 | 0 |
| | Sandstone, laminated, - - - - - - | 0 | 1 | 10 |
| | Parrot Coal, - - - - - - - - | 0 | 0 | 7 |
| | Black band Ironstone, - Fossil remains, | 0 | 0 | 5 |
| | Shale, - - - - - - - - - - | 0 | 0 | 11 |
| | Sandstone, laminated, - - - - - - | 0 | 5 | 1 |
| | Shale, - - - - - - - - - - | 0 | 0 | 8 |
| | Ironstone, clay band, - - - - - - | 0 | 0 | 2 |
| | Shale, - - - - - - - - - - | 0 | 1 | 10 |
| | Coal, | 0 | 2 | 8 |
| | Fireclay, | 0 | 0 | 6 |
| | Coal, "9 feet coal," - - - - - | 0 | 1 | 2 |
| | Shale, | 0 | 0 | 4 |
| | Coal, | 0 | 1 | 3 |
| | Fireclay, - - - - - - - - - | 0 | 2 | 0 |
| | Sandstone, - - - - - - - - - | 1 | 0 | 6 |
| | Carry forward, - - - - - | 62 | 4 | 11 |

* "Bellfield Limestone," the same as at Poniel, 7 feet. † "Smithy Coal."
‡ "Smithy Coal." § Extensively wrought.

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| | Fath. | Ft. | In. |
|---|---|---|---|
| Brought forward, | 62 | 4 | 11 |
| Shale, | 0 | 4 | 7 |
| Ironstone, | 0 | 0 | 1 |
| Shale, | 0 | 3 | 6 |
| Ironstone, | 0 | 0 | 1 |
| Shale, | 0 | 1 | 4 |
| Ironstone, | 0 | 0 | 6 |
| Shale, | 0 | 1 | 6 |
| Sandstone, laminated, | 2 | 0 | 11 |
| Shale, | 0 | 5 | 8 |
| Ironstone, | 0 | 0 | 2 |
| Shale, | 0 | 0 | 4 |
| Ironstone, | 0 | 0 | 2 |
| Shale, | 0 | 2 | 7 |
| Ironstone, | 0 | 0 | 8 |
| Shale, | 0 | 2 | 8 |
| Ironstone, | 0 | 0 | 1 |
| Shale, | 0 | 1 | 8 |
| Ironstone, | 0 | 0 | 5 |
| Shale, | 0 | 1 | 6 |
| Sandstone, | 0 | 3 | 11 |
| Coal, | 0 | 0 | 10 |
| Fireclay, | 1 | 0 | 11 |
| Ironstone, | 0 | 0 | 4 |
| Fireclay, | 0 | 0 | 4 |
| Coal, | 0 | 0 | 4 |
| Shale, | 0 | 2 | 2 |
| Sandstone, | 0 | 1 | 6 |
| Fireclay, | 0 | 0 | 3 |
| Coal, | 0 | 1 | 5 |
| Fireclay, | 0 | 1 | 7 |
| Shale, | 0 | 1 | 1 |
| Coal, | 0 | 1 | 3 |
| Sandstone, laminated, | 1 | 5 | 2 |
| Shale, | 0 | 1 | 10 |
| Coal, | 0 | 1 | 3 |
| Shale, | 0 | 0 | 3 |
| Coal, | 0 | 0 | 10 |
| Shale, | 0 | 0 | 2 |
| Coal, "6 feet coal," | 0 | 0 | 6 |
| Coal, "Gas," | 0 | 0 | 8½ |
| Shale, | 0 | 0 | 1 |
| Coal, | 0 | 1 | 3 |
| Fireclay, | 0 | 1 | 6 |
| Sandstone, laminated, | 1 | 1 | 5 |
| Shale, | 0 | 3 | 11 |
| Sandstone, laminated, | 1 | 5 | 10 |
| Shale, | 0 | 3 | 2 |
| Sandstone, | 0 | 3 | 0 |
| Shale, | 0 | 4 | 5 |
| Ironstone, | 0 | 0 | 2 |
| Shale, | 0 | 0 | 10 |
| Sandstone, laminated, | 2 | 1 | 10 |
| Shale, | 0 | 4 | 0 |
| Ironstone, | 0 | 0 | 2 |
| Shale, | 0 | 1 | 3 |
| Sandstone, laminated, | 0 | 1 | 10 |
| Carry forward, | 85 | 4 | 7½ |

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| No. | | Fath. | Ft. | In. |
|---|---|---|---|---|
| | Brought forward, | 85 | 4 | 7½ |
| | Ironstone, | 0 | 0 | 2 |
| | Shale, | 0 | 0 | 9 |
| | Coal, | 0 | 0 | 1 |
| | Ironstone, | 0 | 0 | 2 |
| | Shale, | 0 | 0 | 10 |
| | Ironstone, | 0 | 0 | 1 |
| | Shale, | 0 | 3 | 1 |
| 5. | Limestone, | 0 | 1 | 1 |
| | Shale, | 0 | 3 | 1 |
| | Coal, | 0 | 1 | 0 |
| | Shale, "Stinking Coal," | 0 | 0 | 10 |
| | Coal, | 0 | 0 | 10 |
| | Sandstone, laminated, | 4 | 5 | 8 |
| | Shale, | 0 | 3 | 11 |
| | Ironstone, | 0 | 0 | 1 |
| | Shale, | 0 | 3 | 9 |
| 6. | Limestone, - Fossil remains, | 0 | 0 | 11 |
| | Sandstone, laminated, | 1 | 5 | 5 |
| | Shale, | 1 | 1 | 8 |
| 7. | Limestone, - Fossil remains, | 0 | 3 | 5 |
| | Shale, | 0 | 5 | 0 |
| | Ironstone, | 0 | 0 | 2 |
| | Shale, | 0 | 1 | 9 |
| | Ironstone, - Fossil remains, | 0 | 0 | 4 |
| | Shale, | 0 | 2 | 9 |
| | Shale, | 0 | 4 | 0 |
| 8. | Limestone, | 0 | 3 | 5 |
| | Shale, - Fossil remains, | 1 | 0 | 0 |
| 9. | Limestone, - do., | 2 | 1 | 11 |
| | Shale, | 2 | 3 | 6 |
| | Sandstone, laminated, - Fossil remains, | 0 | 1 | 8 |
| | Fireclay, | 0 | 1 | 6 |
| | Sandstone, | 1 | 2 | 10 |
| | Fireclay, | 0 | 2 | 5 |
| | Shale, | 4 | 5 | 6 |
| 10. | Limestone, - Fossil remains, | 1 | 0 | 11 |
| | Shale, | 0 | 1 | 6 |
| | Coal, - Fossil remains, | 0 | 0 | 2 |
| | Fireclay, | 4 | 0 | 10 |
| | Sandstone, laminated, | 1 | 3 | 7 |
| | Coal, | 0 | 0 | 10 |
| | Shale, | 0 | 1 | 2 |
| | Fireclay, | 0 | 1 | 8 |
| | Sandstone, laminated, - Fossil remains, | 0 | 5 | 8 |
| | Shale, | 0 | 1 | 7 |
| 11. | Limestone, - Fossil remains, | 0 | 2 | 0 |
| | Fireclay, | 0 | 3 | 0 |
| | Sandstone, laminated, | 0 | 2 | 8 |
| | Fireclay, | 0 | 1 | 0 |
| 12. | Limestone, - Fossil remains, | 1 | 0 | 6 |
| | Shale, - do., | 0 | 2 | 3 |
| 13. | Limestone, - do., | 1 | 2 | 0 |
| | Fireclay, | 2 | 4 | 6 |
| | Sandstone, laminated, | 1 | 5 | 0 |
| | Fireclay, | 1 | 2 | 3 |
| 14. | Limestone, - Fossil remains, | 0 | 5 | 6 |
| | Total, | 134 | 0 | 9½ |

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## XVII.—Notes on the Limestones in the Parishes of Cathcart and Eastwood, Renfrewshire. By James Stewart of Williamwood, with Map and Section [Plates V. and VI.]

[Read 8th December, 1881.]

New bores put down since the publication of the Geological Survey Map of Cathcart and Eastwood parishes (sheets 13 and 17 of the 6-inch scale), show that it stands in need of correction and extension. I have therefore attempted to correct some of the mistakes, and to represent more fully the outcrop of the limestones. The accompanying sheet of bore sections will explain my reasons for the alterations (Plate VI.)

*Bore Sections.*—Twenty-nine sections of 31 bores have been drawn and numbered, and the position of the bores has been marked on the map (Plate V.) with corresponding numbers in red ink.

Section 1 is made up of three bores, of which 1*a* is from the surface of the ground to the pavement of the thin coal under the Orchard cement; 1*b* from thence to the pavement of the Cowglen limestone; and 1*c* from thence to 26 fathoms below the Cowglen limestone. In bore 1*b* the pavement of the coal is 4 feet, and in bore 1*c* the pavement of the limestone is 9 fathoms, from the surface of the ground.

*Position of the Bores.*—The exact position of some of the bores is not known. These are Nos. 4, 5, and 6, which were put down somewhere in Davieland, round the boundaries of which a black line has been drawn; bores 8, 10, 11, and 18, somewhere within the red circles drawn over the numbers; and bore 14*a*, said to have been put down in the same field as bore 14*b*.

*Arrangement of the Sections.*—It is hoped that no mistake of importance has been made in the arrangement of the sections. They have been placed in their vertical positions as carefully as my information will permit of. The pavement of the Cowglen limestone has been taken as the datum line, and the distances above and below it are given in fathoms.

*Cowglen Limestone.*—The district comprised in the quadrangle between Pollokshaws, New Cathcart Bridge, Busby, and Thornliebank, appears to be divided into five areas, separated from each other by faults. I propose to follow the outcrop of the

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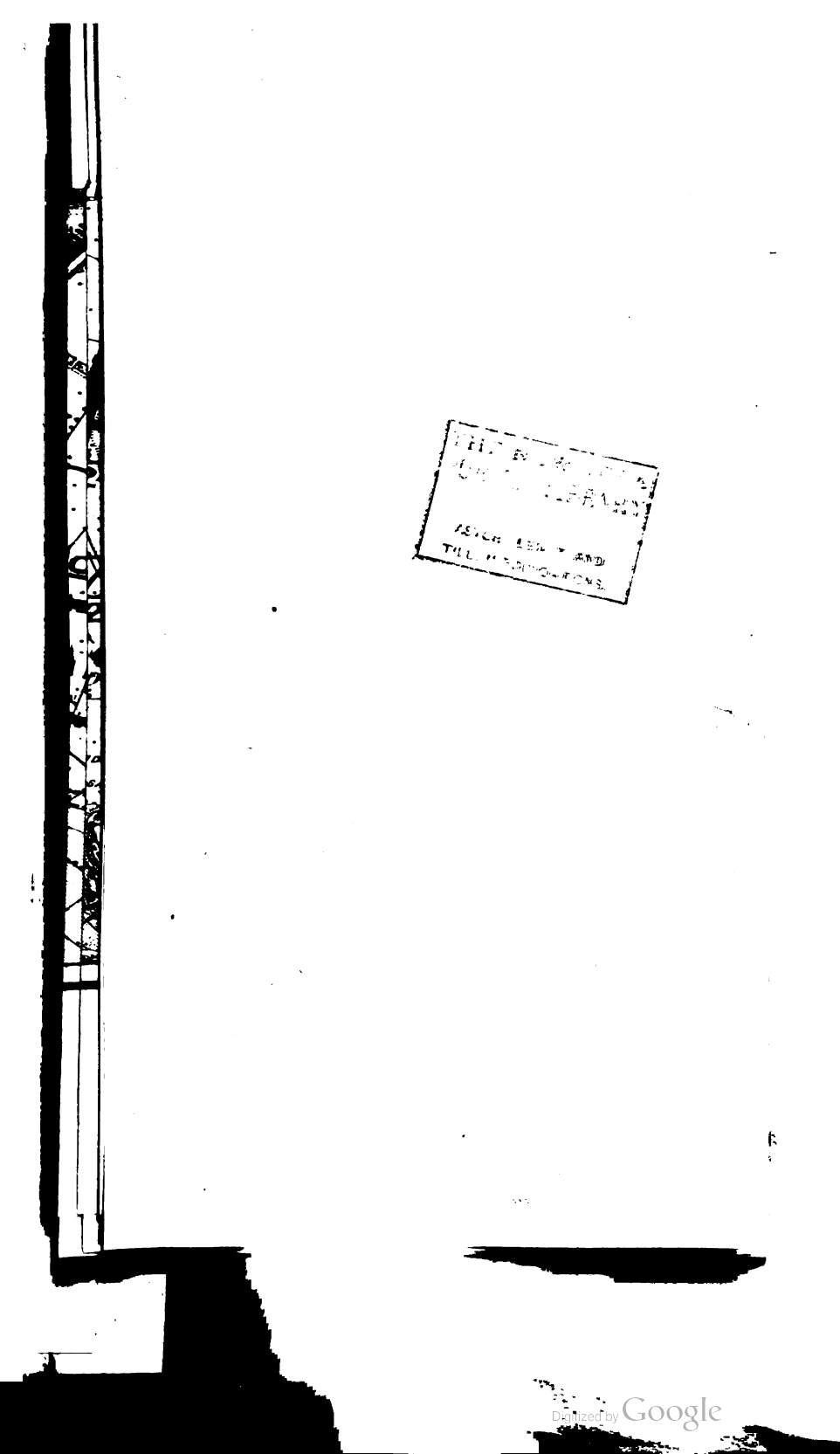
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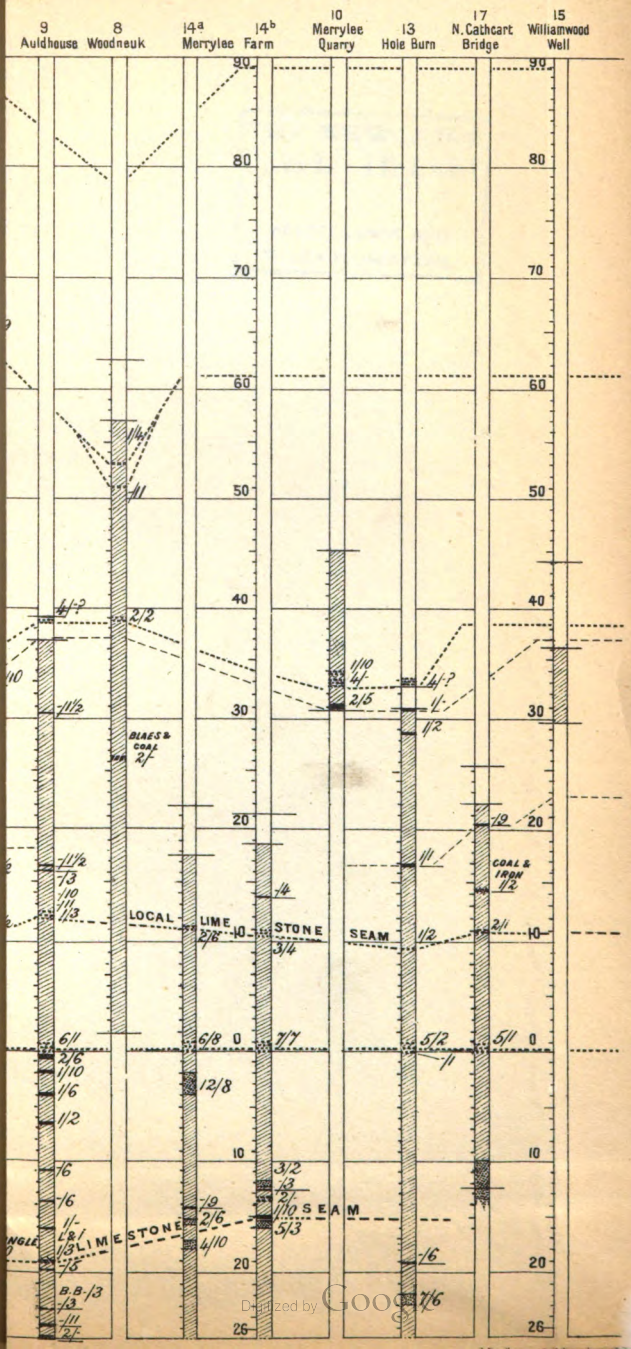
# CTIONS,

## OD, RENFREWSHIRE,

and Volcanic Ash

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limestones within these areas, beginning with the Cowglen limestone, which is the lowest seam that crops out, and marking on the map with short blue bars across the seams the places where they are exposed, or where there is evidence of their presence.

*At Pollokshaws.*—West of Pollokshaws, between the river Cart and the village, the position of this limestone seems to be correctly marked on the survey map; for a bore put down in 1846 in the "Sheep park" passed through the gas coal at 58 fathoms from the surface, and as the gas coal is known to lie just about that distance below the Cowglen limestone it follows that the bore must have been put down from close to the outcrop of the limestone.

East of Pollokshaws, between the burgh and the Hole Burn, the so-called Cowglen limestone on the survey map is proved by bore 13 (put down in 1861) not to be the Cowglen limestone, but a seam lying 33 fathoms above it, which I call the "Hole Burn" limestone.

There must be a fault between the "Sheep park" and the Hole Burn. I have drawn it running from the NE. towards the SW. through Pollokshaws, and I suppose it to have a downthrow to the E., of about 33 fathoms, or sufficient to bring the Hole Burn limestone to a level with the Cowglen limestone of the "Sheep park."

*At New Cathcart.*—The limestone outcrop shown on the survey map between the Hole Burn and the N. end of New Cathcart does not exist. From thence behind the village to the S. it is probably correctly drawn, the seam having at one time been worked there.

*At, and near, New Cathcart Bridge.*—Bore 17, put down in 1874, just W. of the dyeworks, passes through the Cowglen limestone at about 26 fathoms, and into the floating whin at about 36 fathoms. I have accordingly drawn the limestone outcrop, and that of the local seam, 11 fathoms above it, so as to conform with the bedding of the whinstone; and I have produced towards the NW. the fault marked on the survey map as running from Symshill past Old Cathcart Bridge.

*At, and near, Linn Bridge.*—South of New Cathcart the survey map represents the limestones as being abruptly cut off by a fault in a field belonging to the Cathcart cemetery company. If this fault exists at all it must be a very slight one, for the limestone and whinstone re-appear to the SE. just as if there was no fault. I have marked the outcrop from this fault across the river as far as Linn garden. The limestone used to be worked here opencast

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on both sides of the river, and Mr. Allan, the forester, who lives close to the old workings, tells me that at one time there was an "ingoing eye," or subway, driven from near the Linn waterfall to the workings behind New Cathcart. East of Linn garden nothing is known of the limestone.

*In Williamwood and Overlee.*—South of the fault which I have supposed to extend from Linn Bridge towards Eastwood Manse, the limestone and whin are again found. In bore 1*c* the former is 9 fathoms from the surface, and the latter is 12 fathoms lower down—at Linn they are much closer together. Between the fault and bore 1*c* I have drawn the outcrop of the limestone to conform with that of the Hole Burn seam. South of bore 1*c* I have drawn it on the W. side of the river, as far as bore 24, in a line conforming with the lie of the strata exposed on the river banks. Bore 24 passes through the seam at 5 fathoms, and a lime deposit on the face of the cliffs N. of this bore shows that it lies close above the sandstone which forms the top of the cliffs. South of bore 24 the outcrop follows the same southerly direction till somewhere opposite bore 26; it then probably bends to the SE., and passing between bore 26 and Overlee farmhouse, reaches the bank of the river a little to the N. of the railway viaduct, where it may be seen exposed, and where it is marked on the survey map under the wrong name of Orchard cement. The arrows on the survey map show that the strata in the river, between bore 24 and the viaduct, are bent in the same sort of way as I have supposed the limestone to bend.

*Between Busby and the New Kilmarnock Road.*—The Cowglen limestone probably abuts against the whinstone and volcanic ash along the line of fault from Busby to Whitecraigs quarry at a depth from the surface of from 10 to 15 to a little over 40 fathoms.

*Limestone Ten Fathoms above the Cowglen Limestone.*—At about 10 fathoms above the Cowglen limestone there is a local seam varying from mere traces to over 3 feet in thickness. It appears in six of the bores, but does not appear in 1*b* bore, 3, 8, 11, or 18, although they pass through its position.

*Hole Burn Limestone.*—This is the limestone that underlies the Giffnock freestone. It is continuous in area throughout the district, varying in thickness from 1 foot 3 inches at Arden to 7 feet 1 inch at Orchard, and generally has one or more partings. It is

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found in all the bores which pass through its position, and bores 9, 13, and 18 were put down from it. It lies from 31 to 39 fathoms above the Cowglen limestone, and from 22 to 29 below the Orchard cement, excepting at Woodneuk (bore No. 8), where it is only 14 fathoms below the cement.

The Hole Burn limestone is found cropping up within two of the areas into which the district is divided. A fault separates these two areas, and it probably runs from Linn Bridge towards the WNW., in the direction of Eastwood Manse, with a downthrow to the N. of from 33 to 38 fathoms, the amount necessary to bring the Hole Burn limestone into the position that would be occupied by the Cowglen limestone if there were no fault. I have drawn it N. of where it is marked on the survey map, but even my position may be too far to the S. if the fault which was bared in the quarry in Merrylee Wood a few years since should prove to be the same.

*North Area.*—Here the limestone crops up in the Hole Burn close to bore 13; it also crops up under the freestone in Bogton quarry; and it has been proved by boring to pass nearly if not quite under Bogton House. Its outcrop may therefore be presumed to extend continuously from the fault at Pollokshaws to that which runs from Linn towards Eastwood Manse. East of Bogton the outcrop of the Cowglen limestone is so close to that of the Hole Burn limestone, and it then diverges so far from it to the N., that I have supposed and drawn a fault running from Linn Bridge towards the NNW., between Bogton and bore 14*b*, and I have produced it on the other side of the river towards the SE.

The mass of freestone lying over the Hole Burn limestone between Hillhead House and Bogton corresponds in position with the Giffnock rock. It has been worked in quarries at Merrylee Wood, Woodend, and Bogton, but its quality has not as yet turned out to be good. The new quarry lately opened by Mr. Francis Brown in the field W. of Merrylee farmhouse has not been more successful.

*South Area.*—Towards the NW. of this part of the district the Hole Burn limestone is first found cropping up near bore 9, in the newly added portion of Eastwood burial ground, where it gave a good deal of trouble to the men employed in laying off the ground. It underlies the freestone of the quarries which extend for 1½ miles in a nearly continuous line from the burial ground to Williamwood, and its outcrop sweeps round in a curve just north of the quar-



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ries, where it is partially represented on the survey map under the wrong name of Cowglen limestone. It passes through bores 11, 12, and 16, and from bore 16 it probably keeps bending, under a heavy mass of Boulder-clay, towards the S. and W. round Clarkston, till it is again met with in Carolside farm at 11 fathoms from the surface, in bore 23. From bore 23 it continues on in a WNW. direction, through bores 3 and 19, and crossing the burn at this last bore, it bends abruptly to the SW., and passes along the side of the field behind the Kilmarnock milestone, where it was once wrought opencast; then through the well at Cleuch farm-steading, and on to the W., where it is cut through by the Cleuch Burn, and its section exposed in a small plantation, 300 yards E. of the New Kilmarnock road. It then crosses the road about 70 yards S. of Whitecraigs quarry, and passing close to the N. of bore 18 it is probably cut off by the whinstone at the fault near the Capelrig (or Auldhouse) burn, beyond which point I do not know it to appear in this immediate neighbourhood.

The freestone of Whitecraigs quarry overlies the Hole Burn limestone, and is therefore identical in position with the Giffnock freestone.

The officers of the Geological Survey do not seem to have been aware of the existence of the Hole Burn limestone as a distinct seam. Wherever it occurs they have called it something else. To the N. of the Giffnock quarries, in the Arden bore, and in the Hole Burn, they call it Cowglen limestone, and in the Woodneuk bore, Orchard cement limestone.

Looking over the Paisley sheet of the survey map (No. 12) I fancy I recognise the Hole Burn seam in the limestone at the Victoria Mill E. of Nitshill, and in that of the bore NW. of Darnley, which is marked as 3 feet 6 inches thick at 76 fathoms.

*Orchard Cement Limestone.*—In this district the Orchard cement limestone is only found cropping up to the S. of the fault which runs from Linn Bridge towards Eastwood Manse. Towards the NW. it is first found in the Woodneuk bore near Kennishead and next in Orchard farm. Its position between these points as laid down on the survey map may be right, but if, as I am told by Mr. James Jackson of Sheddens, the retaining walls of the filters at Thornliebank print works are founded on limestone rock, it may turn out not to be correct.

From the cement quarries at Orchard to the road leading from

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Clarkston to Cathcart the line of outcrop is correctly given, but beyond the road it is shown as following a SE. direction to the railway viaduct, which is a mistake. Instead of its doing so, a series of shallow bores put down some years since prove that it bends gradually towards the S., till at a point opposite bore 1*a* it lies nearly N. and S., and as the strata exposed further on in the railway cutting near the signal house are seen to dip to the WNW. or NW., the line of outcrop may safely be presumed to pass round Clarkston in an unbroken curve, and then, taking a W. and NW. direction, to join on to the cement in bore 20, which is found, at 9 fathoms from the surface, to lie in its proper position over the Hole Burn limestone of bore 3. From bore 20 towards the W. I have drawn the cement conforming with the Hole Burn limestone, and I have joined it on to the seam which crops up in the burn in the Rouken Glen under Mr. Crum's house (which in the survey map is called Birkenshaw, though it is now known as Thornliebank House), and which, from its position, its appearance, and the character of the overlying fossiliferous strata, I think is almost certainly one of the two seams into which the Orchard cement appears to have forked in this part of the district. See bores 4, 6, 7, and 8.

On the survey map the Hole Burn limestone in the Woodneuk bore is called Orchard cement. The double seam 9 fathoms from the top of the bore is more likely to be the cement.

*Arden Lime.*—I do not know of the Arden lime cropping up anywhere within the district except where it is marked on the survey map, but possibly it may do so somewhere in the lands of Eastwood Mains or Birkenshaw.

*Whinstone.*—Bores 27 and 28 show that the whinstone between the Eaglesham and Mearns roads W. of Busby has its boundary a little more to the N. than it is given on the survey map, and that there is a considerable thickness of volcanic ash overlying the whin. Bores 27 and 18 show that the fault is not quite vertical, but that it inclines towards the N. as it goes down, bringing the volcanic ash and rock under the strata which abut against it on that side (bore 18 went further down than is shown in my section; it passed into whinstone some distance below the Cowglen limestone and was stopped in whin). Bore 6, in Davieland, was probably put down not far from the fault, for it appears to have passed into, and to have been stopped in the same whin.

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*Floating Whin.*—The sheets of floating whin which come from the direction of Aikenhead and are thick at Cathcart, thin gradually out towards the S. and W., and do not reach so far as Eastwood burial ground, or Orchard. They do not appear to penetrate above the Cowglen limestone, but lie at various distances below it.

*Section along the red diagonal line marked A. B. on Map (Plate V.)*—A section along the line A. B., which I have drawn on the map from near Whitecraigs quarry to Clincart Brick and Tile works, through New Cathcart Bridge, will show how, I believe, the strata lie between these points. [This section not having been reproduced, it will be found with the MS. of the paper, which, with the map and bore sections, is now in the Society's Library.]

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## No. XVIII.—Notes on a Carboniferous Selachian Fish from the Cement-limestone Series of East Kilbride.

By James Coutts.

[Read 8th December, 1881.]

The genus *Cochliodus* was established by Professor Agassiz, in 1838, for some peculiar shell-like palatal teeth found in the Carboniferous limestone series, five species being named by him—*Cochliodus acutus, C. contortus, C. magnus, C. oblongus,* and *C. striatus*; but it has since been doubted whether some of these do not rather belong to some closely allied genus. Thus Prof. M'Coy, speaking of *C. magnus,* at page 623 of his "Palæozoic Fossils," says, "This species varies considerably in the outline of the different specimens, and I think it is very doubtful whether it is truly of the genus, on account of the flatness and slight inrollment of the teeth, and the little definition of the characteristic oblique ridges; the strong crenulation of the margin is also a character which I do not recollect to have seen in *Cochliodus,* but recalls the observation of Capt. Jones, (in Portk. Geol. Rep.) that the *Cochliodus magnus,* he thinks, pass into the *Helodus planus,* which may be borne out by a large suite of specimens, although I have not yet myself seen the passage."

I am glad to be able to exhibit to the Society a specimen of this fish, which seems to confirm in a measure the truth of Captain Jones' conjecture, as stated by M'Coy. This fine, I might almost

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say unique, specimen was discovered this autumn by my friend Mr. Andrew Paton, of East Kilbride, in the cement-limestone series, and he has kindly placed it in my hands for exhibition. The specimen consists of the head and cartilaginous jaws, with, apparently, a portion of the shagreen-like skin attached to the head, and there are 32 palatal or crushing teeth visible. The teeth are apparently in position, but are distorted out of their proper places by the oblique pressure to which the skull has been subjected during fossilization, so that it is now impossible to say what may have been its true form, or whether we have now all the teeth possessed by the fish before it was entombed in the sediment in which it now lies. Be this as it may, my object at present is to point out to the members that we have in this specimen several forms of teeth, which formerly were allocated to distinct genera of Selachian fishes. The two largest teeth evidently belong to *Cochliodus magnus*, or, as it is now given in the "Catalogue of Western Scottish Fossils," *Tomodus convexus*, Agassiz. Others of the teeth agree closely in form with *Helodus planus*, now *Psephodus magnus*, Agassiz, thus confirming Captain Jones' opinion that the teeth of *Cochliodus magnus* and *Helodus planus* belong in all probability to the same fish. Some of the teeth in this specimen agree very closely with *H. mammilaris*, Agassiz, while others differ in form from any of the species indicated; indeed it is very doubtful if there are any two teeth exactly alike, but this is a character common to the group of fishes to which the specimen belongs. On close inspection it will be seen that the rounded upper surfaces of the teeth are perforated by minute tubulæ or pores, as in the genus *Psammodus*, and that the outer borders of the teeth are ornamented with vertical plications, presenting a crenulated structure. In this feature these teeth, according to M'Coy, agree more with *Helodus* than with *Cochliodus*. I, however, leave the genus to which this specimen belongs an open question, my object in this paper being to point out that here we have, in one specimen, teeth of various forms, apparently lying not far from their normal position, which formerly have been allocated to distinct genera and species of fish.

Perhaps the above short notes upon this interesting specimen, if followed up by abler hands than mine, may help to throw new light upon this group of Carboniferous fishes. I may also be allowed to remark that it is to be hoped Mr. Paton will continue

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his researches amongst the cement-limestone group of strata, for within the last ten or twelve years he has collected from it numerous interesting specimens of ancient fish life, many of which from time to time I have brought under the notice of the Society.

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## No. XIX.—A Geological Excursion to Cathkin Quarries.

By D. C. Glen, F.G.S.; and John Young, F.G.S., V.P.

[Read 18th May, 1882].

The quarries in the Cathkin district, although visited at intervals by individual members, have never, so far as we are aware, been selected as the scene of one of the Society's excursions until this season, the omission probably arising from their nearness to the city, and consequent accessibility to any one with an hour's leisure. The late discovery, however, of certain interesting magnesian minerals, afterwards to be noted, in fissures and cavities of the dolerite rock of Cathkin, created a fresh interest in the locality, and the first excursion of this season was therefore arranged to visit the workings on Saturday, 15th April last. Leaving the train at Rutherglen the party proceeded along the Stonelaw Road. The air was cold and the atmosphere clear, so that a splendid view was obtained from the higher grounds across the valley of the Clyde to the distant hills beyond. Ben Lomond and the mountain ranges to the west, as well as the Campsie fells and the Ochils, were covered with snow nearly half way down their slopes—the effects of a recent storm—which gave the country lying to the north a truly alpine character.

On the Stonelaw Road were passed one or two old pits which had been put down into strata belonging to the upper coal measures, and from the shales on their spoil-heaps, shells belonging to the genus *Anthracosia*, with ferns and other plant-remains, are still to be obtained. The Rev. David Ure, writing in 1793, in his "History of Rutherglen and East Kilbride" (p. 120), says that "there is no account when coals were at first wrought in this place. But from the number of old wastes the period must be very remote." He states that a cart-load of three hutches, weighing about 13 cwt., was laid down in the streets of Glasgow for 3s. 6d., the carriage being 4d. Also that a considerable quantity of ironstone was turned out along with the coal at Stonelaw,

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which sold at 5s. 6d. per ton on the hill, and was delivered at Clyde Ironwork for 6s. 6d. As some of the old pits around Rutherglen are still being vigorously worked, there may be formed some faint idea of the vast amount of mineral wealth which has been drawn from the strata of this district within the past century. The walk up the Stonelaw Road was very pleasant, the surface appearance of the ground being, as described by Ure, "beautifully diversified with a regular succession of small hills and narrow dales."

Leaving the main road the party passed Burnside skating-pond, and soon entered on the region of bedded traps of upper calciferous sandstone age, which are here brought to the same surface level as the upper coal measures, through the disrupting influence of a great fault which runs from east to west along the northern face of the Cathkins. This fault, sometimes known as the great Eddlewood fault, displaces the strata at some points of its course no less than 400 fathoms, the downthrow of the coal measures being to the north, or towards the trough of the Clyde. South of this fault the bedded traps are seen to dip to the south at an angle of about 10°. They consist of beds of dolerite and felstone, alternating with volcanic ash-beds of various colour, which are often seen to be arranged under stratified conditions. On visiting a new quarry opened in a field a little to the westward of the road, the dolerite was found to be distinctly columnar, the columns averaging from 12 to 18 inches in diameter, and extending in a jointed form through the whole depth of the bed. It was here clearly seen that the above noted dip of the trap to the south must have taken place since the period when the columnar structure had been produced, as the columns, which stand at right angles to the bed of dolerite, are thrown out of their perpendicular, and lean over to the south. During the cooling of the rock and the subsequent contraction which took place, between many of the columns vertical fissures were formed, varying from a sixth of an inch to an inch in width, and these are now seen to be filled with veins of calcite and hydrous oxide of iron combined, the latter being no doubt a result of the decomposition of the dolerite.

The quarry above referred to appears to be opened in the same bed of dolerite as the one to the eastward of the road, which is described by Ure (at p. 269), and he illustrates the section by a

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carefully drawn plate. We were glad to find that the fine section of columnar trap in this old working still exists in the same condition as when it was figured by Ure in 1793, the only difference observable being that some columns are slightly hidden by plants which have grown from various crevices, where they have found sufficient space to give them foothold. We shall here quote our author:—"To this class of stones may be added the *Basaltes*, of which the estate of Cathkin, a little above Rutherglen, affords a beautiful specimen. A Colonnade, consisting of 164 pillars were, by workmen procuring materials for a turnpike road, brought into view. They are about 30 feet high, and a foot and a half in diameter. They are mostly five-sided, but the sides are not equal. A thin *dissepimentum*, some parts of which are ochreous, and others argillaceous, separates them from one another. Not a few specimens of it are very hard, approaching to a vitreous and metallic texture; whilst others are loose, and friable between the fingers. It is generally of a reddish colour, and becomes darker and magnetic by torrefaction. Some of it is porous, having some of the cavities filled with a sooty-like substance, amongst which are found transparent rock-crystals of hexahedral pyramids. In the columns, the transverse subdivisions are very imperfect: in some instances they exhibit a convex, and a corresponding concave surface. The basaltic stone is considerably brittle; does not emit fire with steel; is not acted upon by acids; and is generally of a darkish gray colour. It affects the magnetic needle, a proof that it is not destitute of iron. After being heated in the fire it becomes darker in the colour, and grows so hard as to strike fire with steel. The flames of a blow-pipe readily melts it into a black glass. The columns, some of which are a little curved, incline to the south, at an angle of about 75 degrees. In the west side of the rock, the pillars gradually coalesce into one another, at their bases, till they become a solid mass." There is very little to add to this clear and interesting description by Ure. The sooty substance which he notes as occurring along with the crystallized quartz in some of the partings between the columns is probably *wadd*, an earthy variety of manganese, often found in veins along with quartz. The other substances between the columns are evidently of the same character as those which were observed in the first mentioned quarry—iron oxides combined with silica and calcite in various states of preservation. As many of

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the members present at the excursion looked upon this interesting section for the first time, a wish was expressed that it might long be spared from destruction by the ruthless hand of man, as presenting a fine and instructive section of columnar trap rock, and also as a monument to the truthfulness of the description of it by the Rev. D. Ure, one of the earliest pioneers in Western Scottish geology.

After leaving this spot, a short walk up the hill brought the party to the large quarry, where a bed of dolerite, apparently higher in the series of bedded traps, is at present being largely worked for macadamizing purposes. This quarry has been worked for many years, and in cutting roads of approach to it from the hill-side some of the rocks which underlie the dolerite have been exposed. They are composed of beds of vesicular felstone and stratified volcanic ash of varying colours, but chiefly inclining to grey and reddish-brown tints. These beds form the rock termed "Osmund" in Scotland, and which is so often referred to by old writers on geology. When speaking of this district, Ure thus describes it (page 254):—"This remarkable stone, which is universally known all over the country, is of various colours; as grey, brown, whitish, &c. It is generally so soft, when lately quarried, that it may be cut with a chisel; but afterwards becomes much harder. It breaks in all directions; the surfaces are unequal, and harsh to the touch. It readily absorbs water, and, if recently heated in the fire, the absorption is attended with a hissing noise. The acids do not affect it: nor are the brownish coloured kinds destitute of iron, in its calciform state. The osmund stands a very great heat, without being rent or melted; for which reason it is used for ovens, furnaces, &c., where a strong and constant heat is necessary. But when used for paving ovens, care must be taken to have it all of the same kind: for if one stone is more dense than another, the bread will be unequally fired. For want of this precaution several ovens have been rendered useless, and the stone held in disrepute. In some specimens a great variety of small stones of different substances, colours and shapes are closely cemented together. The greatest part of the osmund, when burnt, assumes a darker colour, and loses three per cent. of its weight, but afterwards regains it by the absorbing of moisture from the atmosphere. Some of it is considerably porous, and almost semi-vitrified: in this case it has, when struck, a strong and clear sound: the pores, in some specimens,

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are pretty large. The osmund is found in large masses in the form of rocks, and in some places it has the appearance of stratification. In many places, as at Kilmalcom, it is found below whinstone, with hardly any other kind of substance intervening. The pores and crevices are, in some specimens, filled with siliceous, and in others, with calcareous spar, and sometimes with Zeolite." Ure concludes his notice of this rock by stating that "it is probable that the osmund is a volcanic production."

There is now little doubt that the group of rocks to which Ure applies the name of Osmund is a truly igneous product, now known and described under the several names of earthy felstone, amygdaloidal felstone, wacke, tufa, mudstone, volcanic agglomerate, and stratified ash-beds. These chiefly belong to the acid group, and, as seen in our trappean hills of Carboniferous age, often alternate with the lava-flows of more crystalline structure by which these ranges are partly built up. Ash-beds are, in fact, the ejectamenta thrown out by the several volcanic vents, and which preceded the later, more liquid lava-flows. In the upper quarry at Cathkin numerous specimens of varying colour, illustrating these more early felspathic rocks, may be obtained. In some of the more vesicular varieties the cavities are filled up with a chalcedonic quartz of a bluish-grey colour, and veins of a greenish chalcedony, resembling a coarse and impure heliotrope or green jasper, are sometimes found. On our visit we observed numerous blocks of amygdaloidal felstone, the fissures in which were traversed by incrusting veins of a stalactitic chalcedony, with a curious rugose surface. The rock, which is here worked for road metal purposes, is a blackish-grey, crystalline, olivine dolerite, varying from 20 to 30 feet or more in thickness. It is rudely columnar in the part of the quarry now being worked, but in earlier years the bed of dolerite, that which lies more to the northern face of the quarry, was very beautifully columnar, and several of these columns are still to be seen in one of the approaches to the workings. They are of much larger size than those in the quarry on the lower level of the hill, which the party previously visited, but like them they stand vertically to the natural bed of the rock, or at right angles to that of the cooling surface.

A dark-green magnesian mineral, first noted from Cathkin quarry by the late Mr. R. W. Skipsey, and described, in vol. ii., page 44, of the Society's *Transactions*, as talcose chlorite or steatite, and which was afterwards analysed and described by the late Mr.

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J. Wallace Young at page 212 of the same volume, as "a green fibrous mineral," is now found to be of the same chemical composition as a similar mineral found in the dolerite of Bowling quarry, an analysis and description of which may be seen at page 64 of vol. vi. of the *Transactions*, where it is named "Bowlingite" by Mr. J. B. Hannay. Since that time the Cathkin mineral has been examined by Dr. Heddle of St. Andrews, who has placed it amongst the varieties of saponite. It is found in fissures of the dolerite along the southern portions of the quarry, and although on the present excursion such fine specimens were not obtained as were got on former visits, still specimens will probably be found so long as the rock is worked backward towards the south.

The interesting discovery this year of another magnesian mineral in the dolerite of this Cathkin quarry by a member of the Society (Mr. Walter Burns), and which was recently analysed, and brought before the Society, by Dr. J. J. Dobbie, at a late meeting of this session, has been shown also to belong to the saponite group, and to a ferruginous variety. Mr. Burns, who was present on this occasion, pointed out the spots where he had found his specimens. These were at two places in the southern portion of the quarry, and their position was found to be at or near the base of the bed of dolerite, where the mineral occurs in irregular, horizontal, lenticular masses, which in their thickest portions vary from six to nine inches.

These two varieties of saponite are very distinct in colour and appearance from one another; that found by Mr. Skipsey being of a dark, blackish-green colour, and of fibrous structure; while the one obtained by Mr. Burns is of a reddish, chocolate-brown appearance, compact in texture, and having a smooth, glossy, conchoidal fracture. It is evident that both varieties, which are distinct in character and mode of occurrence, and not mere alterations of each other, are secondary products of the same olivine dolerite, produced through hydrous decomposition of the rock, which is seen to be soft and serpentinous in character whenever it is in conjunction with the saponite. To distinguish the two varieties in collections, we might suggest that the green fibrous one should be known as Saponite, *var.* Bowlingite, while the compact reddish-brown variety should be called Saponite, *var.* Cathkinite.

A number of specimens having been collected, the party proceeded to the railway station and thence homewards, pleased with the afternoon's work.

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## No. XX.—On a Large Boulder of Mica-Schist near Inverbeg, Lochlomond. By Dugald Bell, Vice-President. With a Woodcut.

[Read 4th May, 1882.]

Some years ago, during an ascent of Ben Lomond, we observed a boulder, evidently of considerable size, perched on the shoulder of the hill on the opposite side of the loch, immediately to the north of Inveruglas or Inverbeg.* It stood out in bold relief between us and the western sky; and we mentally took note of the spot where it lay, with the purpose of visiting it at some future time. During last summer we carried this intention into effect, walking from Luss to Tarbet and taking the boulder by the way.

As members are aware, the lower part of Lochlomond rests on Calciferous and Old Red sandstones. Its upper part, from above Balmaha on the one side and Rossdhu on the other, extends among the old schistose rocks, provisionally termed Silurian, beginning with a belt of clay-slate, which is wrought for roofing purposes in the well-known quarries near Luss, and succeeded by beds generally of a more arenaceous kind, including varieties of mica-schist, chlorite-schist, etc., such as are common throughout the Western Highlands. The prevailing dip of the whole is to the south-east.

The road along the richly wooded shore of the loch, with Ben Lomond rising before us on the opposite side and seen oftentimes through a vista of leafy boughs, presents many aspects of beauty. It belongs, however, more immediately to our subject to state that there are numerous instances of striation observable on the rocks as we walk along, the striæ, of course, running parallel to the principal direction of the loch. Every projecting point, we may say, shows these markings very distinctly, and they are also well seen on some of the little rocky islands near Luss. About half a mile below Inverbeg, where a part of the old road still remains, there is a large knoll, with the top beautifully smoothed and marked with fine straight lines across the surface, about 50 feet above the level of the loch. Nearer Inverbeg, a steep face of schist rises by the wayside, grooved and polished in the same way, the striæ sloping perceptibly *up* the face of the rock, indicating, doubt-

* As there are two places on the loch called Inveruglas, upper and lower, to avoid confusion we adopt the other name which lower Inveruglas is known by, viz., Inverbeg.

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less, a change in the depth or inclination of the rocky bed over which the ice moved. As is well known, the loch, immediately to the north of this point, attains a great depth—from 80 to over 100 fathoms. From opposite Rowardennan Lodge to Luss it is between 30 and 35 fathoms.* All its southern and wider part is comparatively shallow, averaging from 8 to 11 fathoms.

The hollow now occupied by Lochlomond has been, unquestionably, at one time a river valley and at another an arm of the sea; but this form of the lake-bed—a deep hollow, shallowing out seaward—cannot be due either to the action of the sea or of running water. We conclude it is a true rock-basin, scooped out by the ice. When drawn to scale, the slope to and from the deepest part is seen to be very gentle, in fact, taken over short distances, almost inappreciable. This is well shown in Mr. Jack's carefully executed diagram of Lochlomond, which appeared in Dr. James Geikie's *Great Ice Age*.

On the opposite side of the loch, at Rowardennan, the glacial phenomena to which we have referred are presented in a very striking form, and, as formerly noticed, may be traced to a great height on Ben Lomond.† Similar striated surfaces and faces of rock are to be observed along the shores of Loch Katrine, Loch Ard, and, in short, of all our Highland lochs.‡ These lochs are evidently, without exception, old glacier channels.

The hill to the north of Inverbeg is called Stob Goblach, and attains an elevation of 1,400 feet. Further back from the loch is a higher summit, known as Ben Breachd, which rises to 2,200 feet. As we ascend, we pass a good many small or moderately-sized boulders of schistose varieties of rock scattered on the hillside. The one we have come to see is on the very ridge or shoulder of the hill, connected with the summit by a gentle slope, and is about 1,000 feet above the level of the loch, or 1,022 feet above the sea. We find it to be a large oblong mass of mica-schist, measuring about 16 feet in length, 12 feet in breadth, and 8 to 10 feet in height. Its longer axis points from NW. to SE., nearly parallel with, or inclined a little towards, the principal direction of the loch. Its

* Here, right between Inverbeg and Rowardennan, there is a much shallower patch, which may be due, partly at least, to the delta of the Douglas water.

† *Trans.*, vol. iv., p. 302.

‡ At the eastern, or Trossachs, end of Loch Katrine, there is a prominent rocky point which shows upward striation very distinctly.

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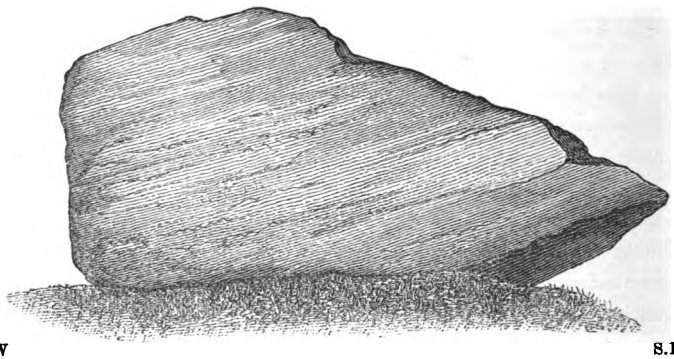
higher and heavier end is that on the north-west; the other or south-eastern face being lighter and more tapering, like the prow of a boat. We could not detect any striæ upon it; the surface being all roughened over, from the softer parts wearing away, leaving the harder ones projecting. Some veins of quartz stand out upon it in



N.W S.E.

bold relief, and it is covered with a profusion of lichens, mosses, small ferns, etc. Immediately to the north, the part of the hill on which it rests slopes rather steeply to the loch. There are no crags near, from which such a mass could have fallen. From its similarity to the general rocks of the district, it is not easy to say from what point it has been derived; probably not from any great distance. If not from the mountains near the head of the loch, it may have been brought from the neighbourhood of Loch Sloy, above Arrochar, where there are a great many scattered rocks of a similar kind, and very striking marks of glaciation.

We may note in passing, that a very beautiful view of the loch is to be obtained from this hill above Inverbeg, and the locality presents other phenomena worthy of notice, such as the very conspicuous delta of the Douglas water, which here projects into the loch.*

The boulder now referred to is one of the highest in

* The deltas of all the streams that flow into Lochlomond—including the Falloch at its northern end, the Douglas, Luss, and Fruin Waters on the west, and the Endrick on the east—are very noticeable. We have sometimes thought that careful observation and comparison of these deltas over a number of years, might furnish some data for estimating the time that has elapsed since the glacial period, or since the last elevation of the land by which Lochlomond became an inland loch.

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position, as well as one of the largest, known to us in the district. The great boulder near Callendoun, between Loch-lomond and Helensburgh, described by Mr. Jack, is only about 300 feet above the level of the loch; and another of considerable size above Banachra Castle, in the same neighbourhood, is not much higher. There are others on Benbowie and the neighbouring hills, at elevations of from 500 to 700 feet, some of which appear to have been brought from a considerable distance, but in general they are comparatively small in size. Dr. Milne Home, in one of his valuable Reports on Boulders, has called attention to the importance of recording those found at considerable elevations, as most likely to throw light on the means by which they were transported to their present resting-places—whether by land-ice or bergs. Of course, the higher such boulders are found—especially those of large size—the greater is the difficulty of supposing them to have been borne by bergs. For, keeping in mind the small floating power of ice—only about one-eighth of the mass being above water and seven-eighths under it—this would necessitate a very great submergence; in the case before us probably not less than twice the height at which the boulder is found. And a submergence of 2,000 feet, or thereby, would so narrow the land surface of our country that we may ask, where could such extensive snowfields and icefields be formed as were required to produce bergs of the size indicated? The supposition that such a boulder, imbedded in a huge iceberg, could find its way to the interior of this valley from some more distant northern source, from some other country lying within the arctic circle, we may at once dismiss as incredible. On the other hand, given the requisite climatal conditions, and *time*, there is no improbability in the land-ice attaining a great thickness in such a valley as this, which would be one of the main outlets by which the ice issued from the great mountain tract in which it was formed. And many other evidences concur in showing that such a thickness and mass it did actually attain.

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## No. XXI.—Notes on Graptolites. By James Dairon. With Two Plates (Nos. VII. and VIII.)

[Read 18th March, 1882.]

### 1. GRAPTOLITES AS FIXED BODIES.

There will always be some difficulty in gaining a knowledge of the life-history of the graptolitic family, from its term of existence having been confined, so far as is known at present, to the Silurian system, and gradually dying out at its close. We have not, therefore, the advantage of having the living recent forms to assist us in our study, there being no existing allies of the family nearer than the plumularia, sertularia, and polyzoa, to which, indeed, the graptolites bear some resemblance.

There cannot be any doubt that certain portions of the sea-bottom in Silurian times were more favourably adapted than others for the reproduction and development of this family, as may be said of the habitats of existing forms of life in our present seas. In proof of. this I may refer to several of the specimens before you, which are covered with a mass of graptolitic remains. These specimens were found in a bed of shale in Garpel burn, and similar remains continue throughout the whole thickness of the bed—about 3 feet—the layers standing quite erect, or vertically, at right angles from the position in which they were laid down. The succeeding bed is about the same thickness, but is only moderately fossiliferous, containing free-floating stipes, both perfect and fragmentary, of several species. The following bed is quite barren, and this great variation occurs in the short space of about 10 feet, though of course it is different according to locality. I believe this variation will be found not only at Moffat, but wherever the black graptolitic shales are found. It does not appear that the graptolites lived only in the seas wherein were deposited these dark-coloured shales, for we find their remains in grey and yellow arenaceous shales in Galloway, also in Wigtownshire, in the Girvan district of Ayrshire, and elsewhere; but in no locality are they so numerous, or so well preserved, as in Moffatdale.

In a late paper (see *Trans.*, vol. vi., page 181) I expressed a desire to procure, if possible, a few more specimens than I then possessed, illustrative of this group, and I am glad to say that I have since been successful in obtaining them. Last autumn, while

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engaged amongst the shale at Garpel burn, near Beattock, I came across several remarkable specimens of different species of the genus *Monograptus*, which to all appearance had been fixed or rooted on the sea-bottom, and had grown in erect tufts or masses, from ½ inch in width and from 2 to 4 inches in height, though in many cases reaching a greater size; and these tufts, before being covered up, had been laid flat upon the sea-bottom. On one of them, towards the base, it will be observed that a few of the stipes are fractured, apparently by the effects of pressure from above. I have also procured several other specimens from the same locality, and many more, illustrating the same and different species under similar conditions, from Dobb's Linn, Beld Craig, and Duffkinnel Burn, the latter being 20 miles from Dobb's Linn and 8 miles from Beld Craig. In connection with this interesting point, I may state that I am now thoroughly convinced that many, if not all, of the species of *Monograptus* may have been fixed to the sea-bottom, or to objects lying or growing on it, and not have been free-floating organisms, as has hitherto been supposed, until at least they were separated from their points of attachment by breakage or by some natural causes. There are many complete stipes, which have been cast adrift, with long perfect initial points, as well as many which have been broken at the very strongest part of the stipe. Intermixed with these are also species of several other genera, as *Rastérites*, *Diplograptus*, etc.

It may be asked, What has injured and detached these bodies? The same bands of shale wherein they are found contain also numerous remains of crustaceans belonging to various species of the genera *Eurypterus* and *Pterygotus*. These creatures were often furnished with formidable-looking mandibles or pincers, which might have proved rather destructive to the slender graptolites whether used as food or not. There are also some smaller crustaceans found associated with them, such as *Dicinocaris Browniana*, Woodward, and several others, specimens of which at various times I have had the pleasure of bringing under the Society's notice.

### 2. REPRODUCTION AND DEVELOPMENT OF *DIPLOGRAPTUS*.

On the occasion previously referred to I brought up for exhibition a number of specimens from the Moffat lower black shales, containing graptolites of the branching forms, on which also at the same time I made some remarks. There was like-



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wise shown at the same time a series from the upper shales, with examples of *Diplograptus pristis*, *D. Whitfieldii*, and *Climacograptus rectangularis*, all exhibiting reproductive sacs attached to each side of their respective fronds (plate vii.) Although these sacs have not as yet been detected upon a number of the species of these genera, it is more than likely that they all followed the same mode of reproduction. On several of the specimens it may be observed, on both sides of the solid axis, that the cellules, where the reproductive sacs have been attached, are seemingly worn away or cast off, which gives them a very bare and skeleton-like appearance. I have never found this to be the case where sacs were not attached, which would almost lead one to the conclusion that the sacs have some connection with this curious appearance. I think, however, from the evidence afforded by the specimens of the various species of *Diplograptus* which I now exhibit with their ovarian capsules attached, that there is no longer any room for doubt as to the mode of reproduction of this genus.

### 3. REPRODUCTION AND DEVELOPMENT OF *MONOGRAPTUS*.

As yet no reliable conclusion has been arrived at as regards the mode of reproduction in this genus, although it has been conjectured that it would be found to show the same mode as *Diplograptus*. Now, I do not see why we should be shut up to this conclusion, when we know that polyzoa, which, as I have previously stated, have some points in common with graptolites, have several modes of reproduction. Probably one of the reasons may have been that previous observers have not been fortunate enough to obtain specimens showing sufficient evidence of the mode of reproduction of the genus, and that therefore the easiest and most natural way of disposing of any difficulty in the matter was to assume that both these genera had similar modes of reproduction. The examples which I have now, however, to bring forward show *Monograptus* in connection with certain fibrous and foliated forms (plate vii.), which I will presently refer to. These seem to have come from one of those favourable spots on the sea-bottom already mentioned, and the enclosing shale in which they now rest must have been favourable for the preservation of such fragile organisms. So far as I am aware, they have never as yet been figured or described anywhere. I have obtained them from the upper black shales of Dobb's Linn, Garpel Burn, &c., and have procured as

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many specimens as will be amply sufficient for the purpose of illustrating the views I now hold on the reproduction and development of several species of the genus. I think it more than probable that other species of *Monograptus* will be found to follow the same mode as those which I have brought forward to-night.

It is not necessary for me to repeat here the views of other observers on this subject, as I have already given them in a paper which I read before the Society on 1st May, 1879, an abstract of which is printed in the *Transactions*, vol. vi., page 206. I may, however, give one extract from Professor James Hall's great work on the graptolites of the Quebec group, as he was the first to introduce the subject, in the year 1858. He says :—"Although I have found none of the monoprionidian forms with reproductive sacs attached, I have nevertheless observed what appeared to be the young of these species bearing an aspect similar to the others, except in carrying the development upon one side only of the solid axis. An illustration of one of these forms is given in fig. 19, Plate B, showing the base irregularly divided. These forms cannot be referred to any mature species." After a careful and lengthened study of the mode of reproduction of the genus *Monograptus*, and having procured a suitable number of specimens of different species from various localities in the neighbourhood of Moffat for the purpose of comparison, I am now thoroughly convinced that the mode of reproduction of this genus is quite different from that of *Diplograptus*. So far as my observation goes, I have never yet found a specimen of *Monograptus* with the reproductive sacs attached, as I would almost certainly have done had they been reproduced in the same way as those of *Diplograptus*. Indeed the chances should have been in favour of finding *Monograptus* with sacs, had they existed, as I believe it to have been fixed in its normal state, and therefore less liable to accident than those which lived in a free-floating condition.

It was formerly supposed, first by Professor James Hall, and afterwards by others, that *Monograptus* was derived from a small dagger-like body about quarter of an inch long, which was supposed to be dehised at maturity from the reproductive sacs, as in *Diplograptus*, and to have grown up afterwards cell by cell until it reached its distal termination. It may be remarked here that no one has been able to determine which end of these bodies is, in their early stage, distal and which proximal. I have many

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specimens crowded with these dagger-like forms, but, strange to say, not one can be found amongst the masses of *Monograptus*.

Among the various specimens I exhibit will be found several containing different species of *Monograptus*, and associated with them are to be seen the tufts I previously referred to, composed of very fine fibrous or hair-like structure. To these I would direct your attention as being really what I consider the earliest stage of the objects which constitute the base or origin of a number, if not all, of the species comprised in this genus. These delicate bodies have often a graceful foliated contour intertwining with the adult forms, and appearing as if they had derived support from them. They may also be observed in all stages of growth, showing the complete development of the cells from their very earliest appearance. Again we find many of them having the fibrous objects I have mentioned, attached right above the solid axis, and also appearing to proceed from near the initial point. One of my specimens obtained from Dobb's Linn and another from Garpel Burn illustrate this. The adult forms are one-sixteenth inch in width, continuing so in straight lengths and overlapping each other, at different angles. The young forms are seen here again above and below them, and exhibit much the same appearance as the adult one.

It has been said that *Monograptus* has most probably been reproduced in the same manner as *Diplograptus*, but only on one side of the solid axis, with only one row of cellules. The latter has, however, a double polipary, resembling a leaf, whereon we find the reproductive sacs attached to each side of the frond, and this has not been found in connection with *Monograptus*. *Diplograptus*, too, is limited in length from $\frac{1}{4}$ inch to 3 or 4 inches at most, while *Monograptus* is practically unlimited; at least some of the species, such as *M. lobiferus*, extend to very considerable lengths.

I hope that these remarks, along with the specimens I have brought forward, will go so far to prove that these delicate fibrous or hair-like structures were the true mode of reproduction of the genus *Monograptus*.

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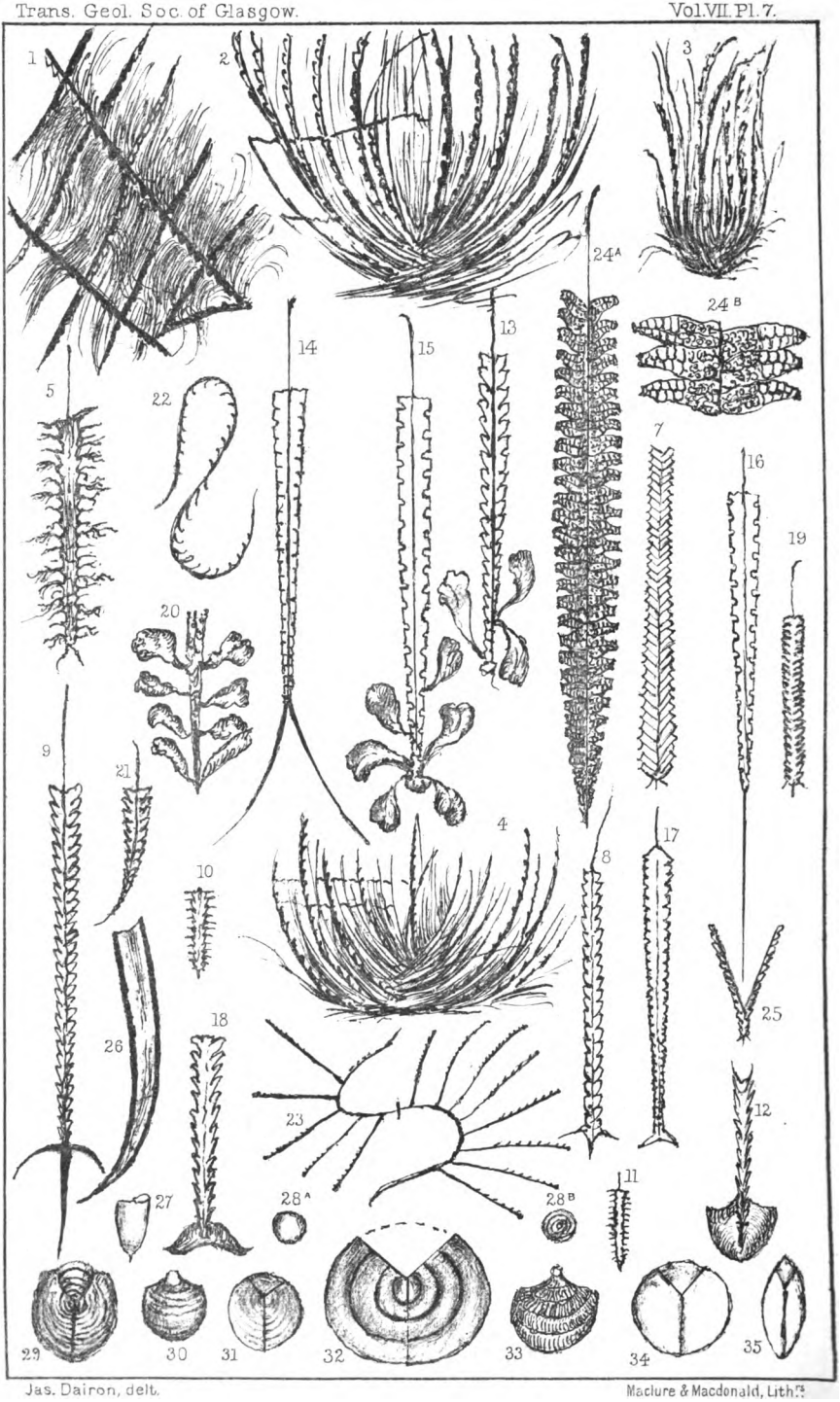


Jas. Dairon, delt. Maclure & Macdonald, Lith?

Moffat Graptolites, &c

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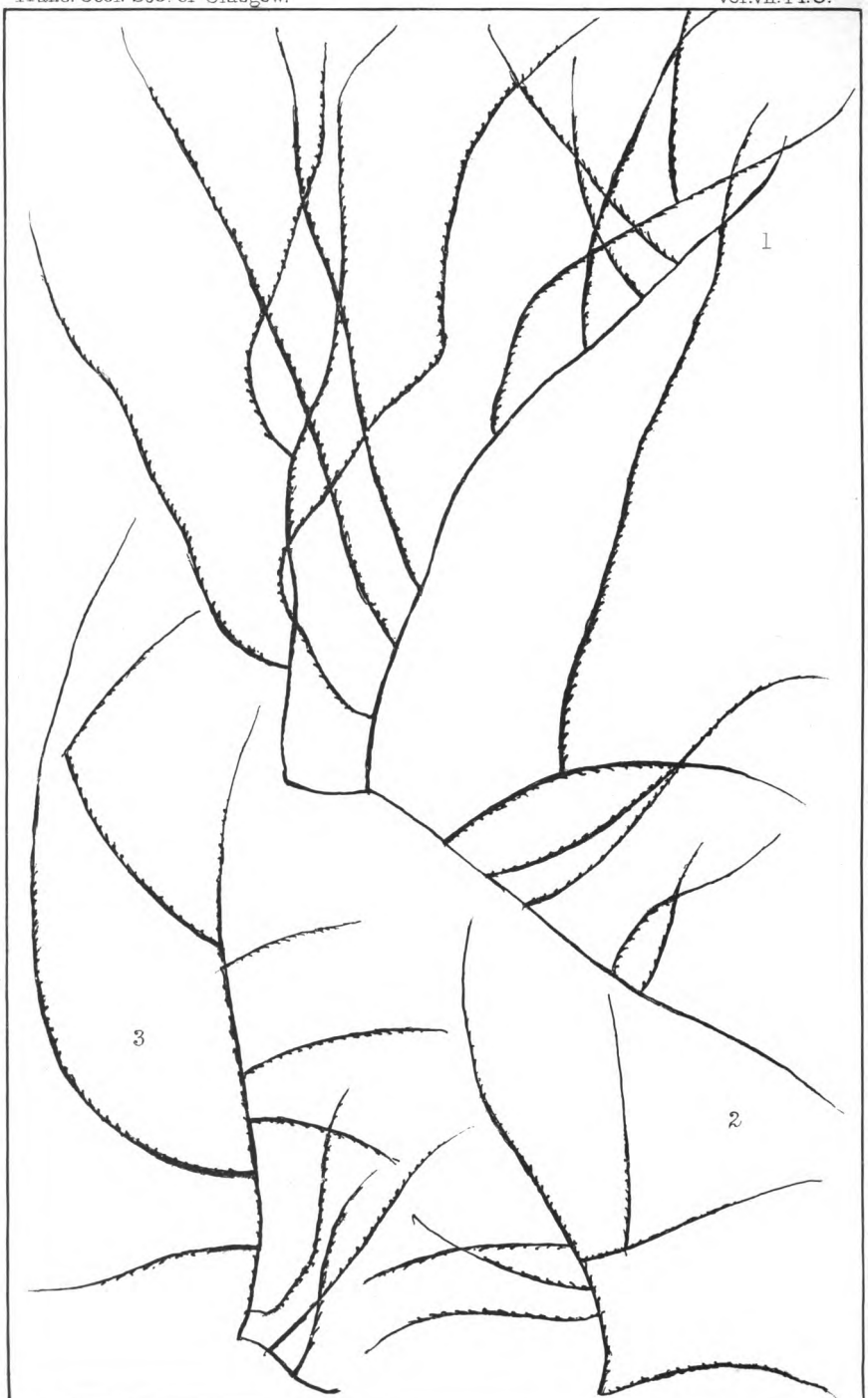


Jas. Dairon, delt.

Maclure & Macdonald, Lith.rs

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Moffat Graptolites.

# EXPLANATION OF PLATES.

## PLATE VII.

1 to 4. Various examples of *Monograptus*, illustrating the manner in which they seem to have been attached to the sea bottom, - Loc. Garpel Burn.

5. *Hallograptus bimucronatus*, Nich., - - - - - - - Hartfell.
7. *Diplograptus pristis*, His., var. *truncatus*, Lapw., - - - - ,,
8. ,, *tricornis*, Carr, - - - - - - - - - - ,,
9. ,, *foliaceus*, Murch., var. *calcaratus*, Lapw., - - - ,,
10. ,, *insectiformis*, Nich., - - - - - - - Dobb's Linn.
11. ,, *innotatus*, ,, - - - - - - - - ,,
12. ,, *physophora*, ,, - - - - - - - - ,,
13. ,, *pristis*, His., with reproductive sacs, - - - ,,
14. *Climacograptus caudatus*, Lapw., var. *cornutus*, - - - - Dairon.
15. ,, sp. (?) with reproductive sacs, - - - - Garpel.
16. ,, *caudatus*, Lapw., - - - - - - - Dobb's Linn.
17. ,, *bicornis*, Hall, - - - - - - - - Hartfell.
18. ,, ,, var. *peltifer*, Lapw., - - - - ,,
19. ,, *per-excavatus*, Lapw., - - - - - - - - ,,
20. *Diplograptus* sp. (?) with reproductive sacs, thecæ removed, Dobb's Linn.
21. *Dimorphograptus Swanstoni*, Lapw., - - - - - - - Hartfell.
22. *Monograptus proteus*, Barr, (?) var. *reversus*, Dairon, bilateral examples.
23. *Cœnograptus gracilis*, Hall, - - - - - - - - - Beld Craig.
24A *Retiolites Daironi*, Lapw., - - - - - - - - - Dobb's Linn.
24B ,, ,, ,, portion of same enlarged, - - ,,
25. *Dicranograptus formosus*, Hopk., - - - - - - - - ,,
26. *Serpulites dispar*, agrees very closely with that figured by Salter, ,,
27. *Dawsonia campanulata*, Nich., - - - - - - - Garpel Glen.
28A *Discina Portlocki*, Geinitz, - - - - - - - - Dobb's Linn.
28B ,, ,, ,, - - - - - - - - ,,
29. *Peltocaris aptychoides*, Salter, - - - - - - - ,,
30. *Acrothele*, sp. (?) resembling *A. granulata*, Linars, - - ,,
31A *Discinocaris Browniana*, Woodw., - - - - - - ,,
32B ,, ,, ,, - - - - - - ,,
33. *Discina trematis*, var. *crassa*, Davidson. - Lower shales. ,,
34. *Discinocaris Browniana* var. (?) - - - - - - - ,,
35. ,, ,, var. *ovalis*, Dairon, - - - - - ,,

## PLATE VIII.

FIG.
1. *Pleurograptus linearis, Carr. prov. compound tribrachiate forms.*
2 and 3. Same species as above.

[NOTE.—Little has been done as yet with this interesting group, although I possess many more examples which will have to become the subject of a future paper. I have submitted the above figures to Professor Lapworth, whom I have to thank for the readiness with which he has responded to my requests for information on doubtful points. His opinion is that "it would be very dangerous at present to attempt to name any fresh specimens till we know more of the group," and with this I quite agree.—J. D.]

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## No. XXII.—Remarks on some of the External Characters which distinguish *Fenestella plebeia* of M'Coy from those of *F. tuberculocarinata* of Etheridge, jun. By John Young, F.G.S., V.P.

[Read 18th May, 1882.]

In the year 1873 Mr. Robert Etheridge, jun., described a species of Carboniferous *Fenestella* at page 101 of the Memoir of the Geological Survey of Scotland, in explanation of sheet 23 (Lanarkshire). The specimens were obtained at Rottenburn, in the Wilsontown district, in shales under the Hosie limestone. Mr Etheridge, after briefly describing this form, says:—"If better specimens should prove this to be a new species, a good name for it would be that of *Fenestella tuberculocarinata*." He only mentions one locality where it had been found, but at that time we had this form from several localities in the lower limestone series of Western Scotland, in all of which it is moderately common, and it also was then recognised as an undescribed species in our collections. Since that period it has been known to us under Mr. Etheridge's provisional name—which was quite descriptive of one of its external characters, viz., its tuberculated keel—so far as ascertained, with one exception: that we had then specimens showing that what he terms "pores on the keel" were only worn-down spines probably originally hollow or tubular, and which looked in the worn state like a row of small pores.

In the *Annals and Magazine of Natural History* (vol. xx., p. 31, July, 1877), Mr. Etheridge briefly described another Carboniferous *Fenestella*, found at Currielee Quarry, Tyne Water, Edinburghshire, compares it with the *Fenestella arctica* of Salter, and names it *F. arctica*, var. *Scotica*, it having, he states, much smaller fenestrules than the arctic form. In describing this species, he says nothing about the characters present on the celluliferous face, so that we may suppose they were unknown to him; but from his description of the zigzag interstices, and hexagonal fenestrules on the reverse face of the fronds, it is evident that we have here a form, as I shall show by and by, identical in all its external aspects with that of *F. tuberculocarinata*, whose fenestrules, Mr. Etheridge says, "have a bulging appearance, caused by a slight undulation of the interstices." He does not, however, say anything about

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this other Scottish species which he formerly described when writing about *F. arctica*, var. *Scotica*.

Mr. G. W. Shrubsole, of Chester,* while reviewing the British Carboniferous Fenestellidæ in a paper in the *Quarterly Journal* of the Geological Society of London for May, 1879, places *F. arctica*, var. *Scotica* and *F. tuberculocarinata*, Etheridge, jun., as varieties of *F. plebeia*, M'Coy. With this, however, I do not agree, as I hope to be able to show that *F. tuberculocarinata* is quite distinct under all its aspects from those of *F. plebeia*; and as the former is an earlier name than that of *F. arctica*, var. *Scotica*, I think it ought to be retained for it, especially as Mr. Etheridge, in the *Quart. Journ. Geol. Soc.* (August, 1878, p. 619), while redescribing *F. arctica*, Salter, from specimens brought home by the late Arctic Expedition, expresses doubts as to this arctic form being a true *Fenestella*, as the cells "appear to be arranged in several rows on each side of the keel," which is a feature certainly not characteristic of any of the true typical forms known to us from Carboniferous strata.

Having now assembled a large series of specimens from different localities, and in various stages of growth and preservation, I am able to show some of the variations which exist in both *F. plebeia* and that of *F. tuberculocarinata*, some of the conditions of variation and preservation being in a great measure due, I think, to the nature of the sea bottom and the kind of matrix in which the *Fenestellæ* have been preserved. Lately I have obtained *F. tuberculocarinata* in its most fully developed form in a bed of greyish white limestone formerly worked in Laigh Baidland Quarry, Dalry, where it is found in old and thickened fronds, measuring in their imperfect state over four inches in diameter. The interstices in most of the specimens from this locality are strongly zigzag; and the fenestrules are hexagonal, the hexagons

* Mr. Shrubsole writes me to say (May 9th, 1882), "I am very much interested in what you tell me about *F. tuberculocarinata*, and thank you very much for the new examples of it. My object in writing is to say that my visit to Scotland quite satisfied me as to it being a distinct species. It is almost clear there are characters in it very dissimilar to other Fenestellidæ —take, for instance, the tubercles over its surface, and the cell mouth. It is very characteristic and distinct, and, not least, the pores to which you called my attention. It is a species well worthy of a thorough critical examination, which I am sure you will give to it."

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being slightly longer than they are wide. The fenestrules average, in the several specimens I have measured, 16 in number in the length of the frond, and 23 in the breadth for every six lines; and these numbers are found to be very constant over large portions of the same frond. A section made by rubbing down a portion of a specimen of one of these thickened fronds shows that the fenestrules at their centre are regularly oval, and that the dissepiments are nearly as thick as the interstices, but the former get thinner as the grinding is continued inwards towards the celluliferous face. The most perfect aspect of the reverse face of a frond from this locality is where we see the surface of the zigzag interstices studded with rather large rounded tubercles, one in general being planted at each angle of the hexagonal fenestrule. These tubercles, when slightly worn or rubbed down on glass with fine emery powder, resemble small round pores, around which the dense outer layer is arranged in a ring-like form; but these tubercular pores here noted for the first time in connection with this species—whatever be their nature—do not pass through the outer cortical layer. I find these tubercles on specimens from other localities but much less strongly developed. Sections which I have ground show that between the dense outer layer and the base of the cells there is a thin second layer, which, when exposed by grinding or weathering, gives the interstices on the reverse face a striated appearance. In the hard limestone from this locality the celluliferous face of the fronds is generally adherent to the stone, but examples turn up where portions of the obverse face are also seen. Where this occurs the cells are found to be arranged on the average—three to each fenestrule, with one row on either side of the keel. The cell-mouths are round, have raised margins, and on their outer edges slightly encroach upon the open space of the fenestrules.

The most perfect condition of the cell pores in *F. tuberculocarinata*, as well as in *F. plebeia* and one or two other forms of fenestrated Carboniferous polyzoa, is where we find the cells covered in by a thin calcareous disc, perforated with a minute pore in the centre. This character I find in some of the specimens of *F. tuberculocarinata* from Laigh Baidland, as well as in those from the Blantyre shales.

I have only now to notice the keel in this species from the former locality. It is seen to be ornamented with a regular row

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of close-set short spines, which were either hollow in their interior or were filled up with a less dense substance than that composing the outer layer of the spines. Specimens showing this tubular character of the spines are easily obtained by grinding portions of the reverse face of the fronds, until the outer face from which the spines project is reached. I have only to add in further remarking on this species from this limestone that some specimens have been naturally fractured along the line separating the cortical layer of the obverse face from that forming the base of the cells. In these the biserial arrangement of the closely-packed cells within the walls of the interstices is seen in the most beautiful manner.

In comparing *F. tuberculocarinata* from this limestone, in which we find this polyzoan in perhaps its highest state of development and preservation, with specimens of the same species from other localities where they seem to have lived under less calcareous conditions of the sea bottom, we find there are no important characters between them by which they can be distinguished, except that of having the external surface of the fronds better developed and preserved. The zigzag character of the interstices and hexagonal fenestrules are to be found in well-grown specimens in all the localities, while the number of cells in the fenestrules and the closely-set spiniferous keel is the same. We therefore see that there are no reliable characters given by which *F. arctica*, var. *Scotica* can be distinguished from that of Mr. Etheridge's previously described *F. tuberculocarinata*, as portions of the same frond often show every change from the slightly undulating interstices and bulging quadrangular fenestrules of *F. tuberculocarinata* passing into that of the more highly zigzagged interstices and hexagonal fenestrules with thickened dissepiments of *F. arctica*, var. *Scotica*.

*Fenestella plebeia*, M'Coy, with which *F. tuberculocarinata*, Etheridge, jun., has sometimes been confounded, is a common species generally in all the localities where it is found, and presents us with one or two well marked varieties. These variations, however, are chiefly confined to the ornamentation of the keel and the reverse face of the interstices, the cell pores, of which the normal number is four to the length of the fenestrule, being generally a constant character in all; while in *F. tuberculocarinata* the number of cells, as formerly stated, is three on each side of the fenestrule, except when bifurcation of the interstices and other irregularities of the fenestrules take place from branching, when

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the cells may be more or less than the normal number; but these variations are to be found in all the species of *Fenestella*— The two species under review can also be distinguished from each other by that of their interstices or branches and the form of their fenestrules. In *F. plebeia* the interstices are generally straight, except where branching occurs, and the fenestrules are longer and narrower in proportion to their length than those of *F. tuberculocarinata*, the difference in the number of the fenestrules of the two species, in specimens from the same limestone, being in the relation of 16 to 10 in six lines when measured along the length of their respective interstices, those of *F. plebeia* being the least in number.

Those who have not been in the habit of examining closely all the characters which distinguish one species of *Fenestella* from another often find great difficulty in correctly identifying some of their specimens; and the difficulty of correct determination is increased when the specimens happen not to be in very good preservation. In regard, however, to the two species noticed in this paper, *F. tuberculocarinata* can easily be distinguished from *F. plebeia* by its fewer cells in the fenestrules, its flexuous or zigzag interstices, and oval or hexagonal fenestrules.

There are other minor characters which might be noted; but these are minute, and can only be fully explained by a study of the specimens themselves. I stated, when speaking of *F. plebeia*, that it presented us with one or two well-marked varieties; and those in my collection are from different localities, and from different horizons of our limestone strata. The first is from the shales in connection with the Belstone Burn limestone, at Gillfoot, Carluke, in the upper limestone series. This interesting form has the interstices of the reverse faces of the fronds acutely angulated; and the sharp middle ridge of the interstice is ornamented with a row of closely-set tubercles, of which there are, on the average, eight in the length of each fenestrule. When looked at from the reverse face, the margin of the fenestrules near to the cell openings is seen to be minutely plicated. The cell-openings on the obverse face of the fronds are four in number to the length of a fenestrule, and the keel of the interstices bear a single row of small close set spines. This variety is not uncommon in the shale at Gillfoot, but I have not met with it in the same fine condition in the strata of any other locality.

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The second variety of *F. plebeia* is that found in the greyish-white limestone of Trearne Quarry, near Beith. In this the rounded interstices of the reverse face bear a single row of irregular tubercles, from four to five in the length of a fenestrule; and the keel of the interstices on the obverse face is likewise ornamented by the same number of short, hollow, or tubular spines, the cells in each fenestrule being of the normal number, as already stated.

A third variety is that found at Hairmyres, near East Kilbride. In this form the keel of the interstices bears only from two to three strong blunt tubercles—the base of spines—in the length of each fenestrule; and these tubercles or spines often give a very rough appearance to the celluliferous face when unworn. On the reverse face the interstices are ornamented with very minute tubercles arranged in several rows, and the cells are of the normal number in the fenestrules. In the form of *F. plebeia* from the limestone shales of High Blantyre, which seems to be nearest the typical variety described by M'Coy, the interstices on the reverse face are minutely granulated when well preserved, and striated when worn; but this latter feature is common to the genus when the outer cortical layer has been denuded, and can be seen in all the species when sections are made. The celluliferous face of the Blantyre specimens have the keel of the interstices ornamented with a row of small spiniferous tubercles, there being from four to five in the length of the fenestrule, one tubercle, a little larger than the rest, being placed at the junction of the dissepiments with that of the interstices. It is probable that all the variations noticed in this species are only the result of changes caused by the different conditions of the sea-bottom on which they lived, and which, when extended over protracted periods of time, as must have been the case in the long life-history of this species, produced those modifications in the hard calcareous covering of the organism that are clearly evidenced by these varieties.

Before bringing these remarks to a close, I wish to state that I am now inclined to think that the perforated calcareous discs which I have discovered closing the cell-mouths of so many of the Carboniferous polyzoa belong to the last stage or fullest development of the polyzoarium, as I find them only closing up the cells in old or full-grown fronds. In young and immature fronds they seem to be absent; while in other somewhat older fronds they may

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be seen in some of the first-formed cells at the base, while they are absent in the newer cells near the top; and in other instances they may be found closing in the mouths of cells in small patches on the fronds at various spots. I have already (*Transactions*, volume vi., page 212) called attention to this peculiar character, and recorded the several species in which they had been found; and I have now to state that they were likewise found in *F. tuberculocarinata*; while I expect they will yet be discovered in other forms in which the fronds have been well developed. While these diaphragms or perforated discs would therefore seem to indicate the adult stage or perfect development of the cells, may they not likewise indicate gradually decaying vigour in the life of the individual polyzoans, which were perhaps necessitated to close in their cells with a thin calcareous cover for protection, leaving only a small opening in the centre to admit as much sea water as, for a time, would sustain their failing vitality? I now think that such probably was the case; and if so, it fully explains the nature and use of these discs in the several species of polyzoa in which they are found.

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# PROCEEDINGS FOR SESSION 1880-81.

## (23RD SESSION.)

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SOCIETY'S ROOMS, ANDERSON'S COLLEGE, 14TH OCTOBER, 1880.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

The CHAIRMAN gave a short address on the prospects of the forthcoming session, congratulating the members on their once more meeting together, and hoping that their gatherings would be in the future as in the past harmonious and instructive. He begged that the spirit of honest and fair criticism might not be repressed, but might find free expression amongst them, and that whatever was mooted might be in the interests of scientific research. He referred to the intended removal of the Society's meeting-place from Anderson's College, where it had been long located, to the new rooms of the Philosophical and Engineers' and Shipbuilders' Societies in Bath Street, and stated that he believed the change would prove beneficial to the Society, and would lead to a large accession to the membership. He then spoke in high terms of the Presidential address given by Professor A. C. Ramsay at the late British Association meeting at Swansea, and also of the address given by Mr. Sorby, President of Section D (Geology), advising the members to give the latter careful study, as dealing exhaustively with the latest points in Geological science.

Mr. GEORGE ALEXANDER then exhibited a number of Fossils from the Hippurite limestones in the neighbourhood of Lisbon, illustrating his remarks on the geological features of the district by a large sketch map. These rocks are the equivalents of the upper beds of the English chalk, and therefore belong to the Cretaceous period. They are traceable for a considerable distance north of the Tagus, and the hills composed of them form a prominent feature in the landscape. The strata are of considerable thickness, and are made up of soft argillaceous limestone and beds of marl, alternating with fossiliferous strata and with beds of hard compact limestone of a white colour. The organisms from which these rocks are named are said by Dr. S. P. Woodward, the great authority on them, to be "the most problematical of all fossils; there are no recent shells which can be supposed to belong to the same family; and the condition in which they usually occur has involved them in greater obscurity." A fine collection of them, formed by the late Dr. Scouler, may be seen amongst the collections of Anderson's College.

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Mr. THOMAS NAISMITH exhibited a fine series of specimens of Crystallized Calcite from the intrusive dolerite of Craigpark Quarry, Dennistoun, principally collected by himself. He said that the present face of the quarry is about 50 feet in height, at the foot being a bed of shale. At one part of the workings the rock suddenly crops out to the surface and then quickly dips to the east to a great depth. About two years ago the workmen came to a very heavy "trouble" in the shape of a newer intrusive dyke, probably the agent which has dislocated the dolerite and caused the numerous cavities, fissures, and "backs" in the rock. The Crystals of Calcite, which are of a pale orange colour, are found in these fissures and cavities where there was room for their proper development; while the Calcite is found in a massive state in veins, of which a very continuous one was lately found extending from west to east. The colouring matter of the crystals is principally iron, and they are sometimes found associated with crystals of quartz. Mr. Naismith further said, that his friend, Mr. Arthur Pratt, had given him an analysis of the porphyritic dolerite which contains the calcite, as follows :—

| | |
|---|---|
| Silica . . . . . | 51·0 |
| Alumina . . . . . | 14·0 |
| Potash . . . . . | 0·2 |
| Soda . . . . . | 3·4 |
| Lime . . . . . | 10·0 |
| Magnesia . . . . | 5·5 |
| Oxide of Iron . . . . | 14·7 |
| Loss . . . . . | 1·2 |
| | 100· |

Mr. ARTHUR PRATT exhibited a number of specimens of Asbestos from Lochfyneside, and said :—During a short holiday this summer I visited the quarry at St. Catherine's on the south side of Loch Fyne, and from whence came the building material for the additions to Inverary Castle made after the recent fire. The rock is a talcose chlorite schist, and forms a very durable building-stone. The old Castle was constructed with the same material, and the edges of the stones are still as sharp and clean as if newly hewn. These were, however, quarried further down the Loch, on the Strachur road, than the new quarry; but the workings are now feued and converted into a garden. The stone at present wrought is not of quite so good a quality as that from the old workings.

I found the Asbestos of which I show specimens in the new quarry, where it occurs in fissures and cavities, lying at right angles to the line of fracture. Asbestos or Amianthus is a very interesting mineral, and does not occur by any means plentifully in this country. There are several varieties, named, according to slight differences in their appearance, Rock Wood, Rock Cork, Mountain Leather, &c. Asbestos belongs to the hornblende group of minerals, and is largely composed of silica, which forms more than half its bulk, or 58 per cent., magnesia 25 per cent., lime

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12 per cent., with traces of alumina, manganese, iron, and water. In old times it was used in the manufacture of incombustible cloth and for lamp wicks, and it is now largely in demand for a variety of purposes, including machinery packing, gas fires, incombustible paint, &c.

Mr. JAMES WHITE read a paper entitled, "Some Notes on a Recent Trip in Ireland, and Thoughts suggested by them," which he illustrated by a number of specimens from the districts spoken of [see page 37].

Owing to the lateness of the hour, the discussion on Mr. White's paper was reserved till a future meeting.

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SOCIETY'S ROOMS, 207 BATH STREET.

ANNUAL GENERAL BUSINESS MEETING, 4TH NOVEMBER, 1880.

Mr. D. C. GLEN, F.G.S., *Vice-President*, in the Chair.

Mr. A. Paton, East Kilbride, was elected a Corresponding Member, and Messrs. John Harvie, Clydesdale Bank; James Henderson, M.A., St. John's Academy, Annfield; W. A. Koch, M.A., F.G.S., Metallurgical Chemist, Parkhead Forge; James Lawrie, M.D., 6 West Garden Street; George Paterson, 73 Nicholson Street, Greenock; James A. Reid, writer, St. Vincent Street; James Stewart of Williamwood, Cathcart; and Rev. W. Williams, 14 Queen's Terrace, were elected Ordinary Members of the Society.

Mr. MURDOCH read the Report of the Council for the past year, as follows:—

At the beginning of the 23rd Session, the Council have again the pleasing duty before them of reviewing the work of the bygone year, and accordingly they now beg to lay before the members the following Report, which will be found, they believe, on the whole satisfactory.

The Society having last year attained its full majority, a proposal to celebrate the occasion in some suitable way was made; and a supper party having been fixed upon by the Council, a Committee was appointed to make the necessary arrangements. The gathering took place on the evening of 23rd February, 1880, at the Alexandra Hotel, Bath Street, under the chairmanship of Mr. D. C. Glen, F.G.S., Vice-President; and a large party having assembled, a pleasant evening was spent, a hope being expressed that similar gatherings might become annual. During the evening the Chairman gave some interesting details regarding the progress of the Society; and Mr. Thomas M. Barr, C.E., one of the original members, read a series of notes on its formation and early history. At the following Council meeting it was agreed that Mr. Barr should be asked to extend his notes with the view of drawing up an exhaustive paper on the subject, which might be read at a meeting of the Society and afterwards printed in the *Transactions*. This request Mr. Barr kindly acceded to, and for the purpose received all the early minute books of the Society on loan, but from want of time he has not yet been able to complete his paper. Since read, see page 97.]

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The Membership of the Society continues in a satisfactory condition, the names on the roll amounting to 212. During the year 16 new members were enrolled, but fully as many names were withdrawn through death or other causes, the total therefore being much the same as last year. Members may perhaps be here fitly reminded that the well-being of the Society depends, and must always continue to depend largely, on their own personal endeavours to bring in new members, and the Council hope that this will not be lost sight of during the new Session.

No Life Members were added to those on the roll during the year, though in this direction there is a wide field to work upon. It may be again stated that the money received for life membership subscriptions has been retained as a separate fund, and now forms a small capital sum, which is well invested, and yields an annual income equal to the subscriptions of 10 members.

The Meetings of the past Session were nine in number, the attendance being generally good; while an ample supply of material, both in the form of specimens with remarks, and papers on practical and theoretical geology, was brought forward. Several important papers were contributed by Honorary and Corresponding Members and by other friends of the Society outside of the ordinary membership, and to these gentlemen, therefore, thanks are specially due. The Council would urge upon members the importance of their bringing forward the results of their investigations, any facts, however small, being always welcomed as contributions to the common stock.

There were no Special Meetings during the year, nor did Sir William Thomson deliver a Presidential Address, his engagements having prevented him carrying out such an arrangement; but the Council hope that the Society may soon be favoured with a contribution similar to those which Sir William has already given.

The Excursions arranged for the Spring and Summer of 1880 were as follows:—

| | | |
|---|---|---|
| Darnley and Arden, 24th April, | conducted by | Mr. James White. |
| Kilsyth, 8th May, | ,, | Mr. John Young, F.G.S. |
| Dunoon (Queen's Birthday), 20th May, | ,, | Mr. D. Wilson. |
| Garvel Park, Greenock, 22nd May, | ,, | Mr. D. Robertson, F.L.S., |
| Auchenskeoch, 5th June, | ,, | Mr. John Smith. [F.G.S. |
| Barrhead, 19th June, | ,, | Mr. D. C. Glen, F.G.S. |

The whole of these were well attended and successfully carried out, the element of weather, so unpropitious in some former years, having proved very favourable. Thanks are due to all the gentlemen who acted as conductors of the various excursions. An extra excursion, for the purpose of inviting the members of the Edinburgh Geological Society to visit some of the hunting grounds of the west country, was arranged for Saturday, 26th June, and proved very successful. It was taken to the Beith district, under the leadership of Mr. Robert Craig, Langside, Beith. In the evening, after the return to Glasgow, the Edinburgh friends were enter-

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tained to dinner in the Cobden Hotel, Argyll Street, under the Chairmanship of Mr. D. C. Glen, F.G.S.; and the large party present spent an agreeable evening.

As stated in last year's Report, a number of the more recent geological works were added to the Library during the session, and these have, as was then anticipated, proved a source of much attraction to readers. The number of readers has, however, not increased in the same proportion, which is a cause of regret to the Council. They hope that a new arrangement of the Library, with a new catalogue which is intended shortly to be made, will induce many more of the members to make more use of the Library than at present is the case. There is also the intention to continue to add the newly-published geological works as they appear, so that the Library may be kept fully abreast of the latest developments of the science.

As regards the *Transactions* it may be mentioned that the distribution of the last-published part (i., vol. vi.) was made during this year, and was statistically as follows :—

| | | |
|---|---|---|
| To Life Members, | 20 | copies. |
| Ordinary Members, | 200 | ,, |
| Honorary ,, | 11 | ,, |
| ,, Associates, | 6 | ,, |
| Corresponding Members, | 23 | ,, |
| Exchanging Societies, | 51 | ,, |
| Total, | 311 | ,, |

A new part is in preparation, and will, it is hoped, be ready for issue during the current year.

As may be realised by the change in the meeting place of this evening, the long-talked-of removal of the Society's "local habitation" from Anderson's College has at last become an accomplished fact. Arrangements have now been finally completed by which the Society will have the use of two elegant and commodious rooms in the new building at 207 Bath Street, in the joint property newly erected by the Philosophical and the Engineers' and Shipbuilders' Societies, and at a very moderate rent indeed. This arrangement, which there is no reason to doubt will be for the benefit of the Society, has been brought about mainly through the exertions and good offices of Mr. Archibald Robertson, one of your Members of Council, and to him, therefore, it is only right that a special and hearty vote of thanks should be awarded.

In conclusion, the Council may express a hope that the Society will long continue to do as good work in the future as it has done in the past, each individual member working for the benefit and in the interest of not only himself, but of his fellow members and co-workers.

J. B. MURDOCH, Hon. Sec.



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*Report by the Treasurer for* 1879-80.

| | | | |
|---|---|---|---|
| The funds of the Society last year, exclusive of publications, amounted to ... ... ... ... ... ... ... | | | £222 10 2 |
| Less the Liabilities it then owed, ... ... ... ... | | | 46 14 9 |
| Net Stock, ... ... ... ... ... ... ... ... | | | £175 15 5 |
| This year the Society's funds, exclusive as above, amount to | | | £225 3 5 |
| Less Martinmas Rent, ... ... ... ... | £5 0 0 | | |
| Printers' Account, .. ... ... ... ... | 1 7 1 | | 6 7 1 |
| Net Stock, ... ... ... ... ... ... ... ... | | | £2.8 16 4 |

The Society is therefore £43 0s. 11d. richer than it was last year, after paying all expenses for the year just ended.

The Treasurer reported a year ago that he had recovered the subscriptions of 194 Members, including 12 new ones, with arrears from 3. He reports this year that he has recovered subscriptions from 189 Members, including 16 new ones, with arrears from 11. From this it will be observed that the income from subscriptions is in a normal state, and varying much from year to year, but still keeping up.

The printing a year ago was only £25 3s. 3d., and the other ordinary expenses of the Society £28 8s. 11d.—in all £53 12s. 2d. This year the printing has amounted to £64 3s. 0d., the ordinary expenses to £37 9s. 0d., and new books £7 17s. 5d.—in all £109 9s. 5d. From this it will be seen that the normal expenses have increased by a sum of nearly £56; and it may be asked, why, if this be so, should the funds of the Society have increased by the sum above-mentioned—£43 0s. 11d. ? The answer to this question is found in the fact that in striking the net stock of the Society last year the then liabilities were taken into account, amounting to £46 14s. 9d., leaving a free stock, exclusive of publications, &c., of £175 15s. 5d.—and the free stock this year being £218 16s. 4d., the difference of £43 0s. 11d. is necessarily increased stock. But it will be remembered that the present year's disbursements, especially the printing account, consist largely of the £46 14s. 9d. already mentioned, so that the apparent anomaly disappears.

It is therefore evident that the Society's funds are in a very sound condition, and gradually improving.

JOHN WIGHT, Treasurer.

[The Treasurer's Financial Abstract will be found at page 223.]

The vacancies in the list of office-bearers were then filled up as follows:—Mr. Archibald Robertson, Vice-President; Messrs. David Sandeman, John Kirsop, James C. Christie, David Forsyth, and James White, Members of Council, the latter gentleman (Mr. White) to take the place of Mr. Archibald Robertson, and therefore for only two years; Mr John Wight,

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C.A., Treasurer; Messrs. Richard Neilson and Joseph Sommerville, Librarians; Mr. James B. Murdoch, Hon. Secretary; and Mr. Gavin Pratt, Joint Secretary.

Mr. JAMES COUTTS exhibited specimens and drawings of a Carboniferous Crustacean from his own collection and from that of Mr. Andrew Paton, *Corresponding Member*, obtained from the cement-limestone series of East Kilbride.

Mr. JOHN YOUNG, F.G.S., stated that this Crustacean belonged to an ancient form of shrimp of the Macrura group, being about the same size as the common edible shrimp, *Crangon vulgare*. It seemed to be closely allied to, if not identical with, a North American species, *Palæocaris typus*, but better preserved specimens than those hitherto obtained might prove the Scottish species to be distinct. No entire specimen has as yet been found, the organism sometimes occurring in the shales in the form of the last segments of the body with the expanded tail fins, and at other times with nearly all the body segments, limbs, and antennæ, but without the tail fins. It is to be hoped that perfect specimens may yet turn up during the working of the limestone.

Mr. RICHARD NEILSON exhibited a specimen of a small Carboniferous fish from the bituminous shale overlying the lower Carboniferous limestone at Braehead Quarry, near Busby. Mr. Young referred the specimen to Dr. Traquair's new genus *Elonichthys*, which was formerly placed amongst the Palæoniscus group of fishes. He stated that this was one of the lowest geological horizons in the Carboniferous limestone series of the West of Scotland for ganoid fishes of this group, though examples of it were, however, found in still lower horizons of Carboniferous strata, in beds of the calciferous series, indicating either lacustrine or marine conditions of deposit.

Mr. JAMES DAIRON read a paper entitled, "Notes on several new Forms of Graptolites from the Silurian Shales of Dumfriesshire," and which was illustrated by a series of specimens. [See page 43.]

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SOCIETY'S ROOMS, 207 BATH STREET,
9TH DECEMBER, 1880.

Mr. ARCHIBALD ROBERTSON, *Vice-President*, in the Chair.

Messrs. Thomas Whitelaw, Motherwell, and R. S. Carmichael, 3 Stirling Street, Paisley, were elected Ordinary Members of the Society.

Mr. JAMES C. CHRISTIE exhibited a series of specimens from the Basalt of the Siebengebirge, on the Rhine, collected by himself during a tour which he had taken through that district last summer. Though many of the same minerals occur in the basalts of this country, foreign examples are usually finer and more massive, and are therefore of great interest to all mineralogists. Amongst others, Mr. Christie's collection contained Arragonite, Braunspath or Bitterspar—a variety of Dolomite,—Sapphire, Zircon, Harmotone or Cross-stone, Ilmenite or Titanic Iron, Natrolite, Phillipsite, and

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Sphærosiderite—the rare botryoidal or vesiform form of Siderite. In the course of a lengthened description, Mr. Christie entered fully into their chemical constituents and mineralogical affinities.

Dr. DOBBIE, in making a few remarks, said that the members were much indebted to Mr. Christie for bringing before them so many specimens of beauty and interest, and which bore so much relation to our native specimens of minerals.

Mr. W. E. KOCH, F.G.S., said that the true reason why we did not find oftener in our home rocks some of the minerals exhibited by Mr. Christie was because we did not sufficiently look for them. Of course they did not occur except in more minute forms, and therefore were too frequently altogether passed over. The only proper method of detection was to grind down slices of every rock, and submit them to thorough microscopic examination.

Mr. JOHN YOUNG, F.G.S., V.P., and Mr. JOHN MAYER, F.C.S., also made some remarks on the subject.

Mr. JAMES COUTTS exhibited a series of fossils from East Kilbride, and from the collection of Mr. A. Paton, *cor. mem.* These specimens, many of which were of great interest, were found in the shales of the cement-limestone beds of the district, and comprised several rare and one or two new and unnamed forms of fish remains, amounting in all to above 30 species. Amongst the mollusca were *Posidonomya membranacea*, not previously recorded from the Carboniferous shales; and a *Trochus* or *Platychismus* still unnamed.

The discussion upon Mr. James White's paper entitled, "Some Notes on a Recent Trip in Ireland, and Thoughts suggested by them," which was read at the October meeting [see page 37], was then taken up.

Mr. JAMES THOMSON, F.G.S., said he had yet to learn in what part of Ireland it was that Mr. White discovered proofs that the Coal and Ironstone series had been so entirely denuded away as he had stated in his paper. From his own knowledge of Irish geology, he quite endorsed Mr. G. H. Kinahan's (of the Irish Geological Survey) statements that those beds, said by some writers to have been entirely denuded away from the great central plain of Ireland, had never really any existence in fact.

Mr. JAMES C. CHRISTIE said he could not agree with Mr. White's remarks upon the metamorphic rocks, and thought that nothing more than theory could be adduced in support of them.

Mr. JOHN YOUNG said that so far back as 1864 the theory of the denudation of the Carboniferous rocks of Ireland was clearly set forth by Professor Archibald Geikie, in a small work which he then published, and that was strong testimony in support of Mr. White's views.

Mr. WHITE, in reply, said that as regarded his remarks upon denudation he had followed the lead of Professor Hull, Director of the Irish Geological Survey, as clearly set forth in his recent work on the Geology of Ireland; while as for the statements he had made on the subject of metamorphism, they were the views of Mr. Green, the well-known geological writer, in whose lately-published work they would be found at length.

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Mr. ARTHUR PRATT then read a paper "On the Igneous Rocks of the Kilmalcolm District" [see page 46], illustrating his remarks by a fine series of rock specimens prepared for microscopic examination.

Mr. JOHN YOUNG, in proposing a vote of thanks to Mr Pratt, said that the district he had spoken of was not known to the Society, although some of the individual members might have visited it; and he therefore hoped that an excursion to it, under Mr. Pratt's guidance, might form a portion of next season's excursion programme.

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SOCIETY'S ROOMS, 207 BATH STREET,
13TH JANUARY, 1881.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

Mr. JAMES COUTTS exhibited another series of specimens, principally from the collection of Mr. A. Paton, *cor. mem.*, and from the cement-limestones of East Kilbride, comprising *Conularia quadrisulcata*, *Lithyrocaris testudineus*, *Nautilus ingens* (young shell), *N. Leveilleanus*, *Griffithides sp.* (cast), and others.

Mr. JOHN KIRSOP exhibited a variety of specimens of interest, including Itacolumite or Flexible Sandstone from Delhi, Agate with open crystalline cavities from South America, and native examples of the same, Fluor Spar, &c., on which remarks were made by the Chairman, Mr. D. C. Glen, F.G.S., Mr. Christie, and others.

Mr. JAMES WHITE exhibited a specimen of Mica-schist from Sutherlandshire said to contain gold, but in small quantity, as analyses had not conclusively proved its presence. One trial said there was gold and another that there was not, so in any case the quantity must be very minute.

Mr. JAMES DAIRON exhibited several specimens of Crustaceans, belonging to the order Merostomata and sub-order Eurypteridæ; also specimens of *Serpulites dispar*, *Estheria*, &c., from the Moffat district, and all new to that locality. Mr. Dairon said that the specimen of *Pterygotus*, which he had obtained last summer in the black graptolitic shales at Garpel Burn, near Beattock, belonged in all probability to a new and undescribed species. The chief interest attaching to its discovery, however, was that it was found in a much lower horizon than any specimens of the genus yet found in this country. Not being quite satisfied as to its identity, he had on a late visit to London taken the specimen to Dr. Henry Woodward of the British Museum, who pronounced it to be one of the ectognaths or swimming feet, with the jaw attached, of one of the species of *Pterygotus*, and that it was figured and described in his own and the late Mr. Salter's monograph, published by the Palæontographical Society. It is there stated that "although *Eurypterus* was the first discovered genus of this sub-order both in this country and also in America, I have nevertheless preferred to commence this monograph with the genus *Pterygotus* as having become historically the most important in England; its affinities having been studied and its structure described by such distinguished naturalists and palæonto-

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logists as Messrs. Agassiz, M'Coy, Salter, Huxley, and Hall. The genus *Pterygotus* not only contains the largest species of the whole order, and probably of the whole crustacean class, but the remains of several of the species are exceedingly perfect and complete."

It is known that for the last fifty years or so *Pterygotus* has been got in the Devonian flagstones of Forfarshire, and portions of them obtained by the quarrymen there were named "Seraphims," from their supposed likeness to the wings of such. Mr. James Downie of that county seems to have done good work in their collection, and many of his specimens are in excellent preservation and almost perfect, some of them measuring six feet and upwards in length. Mr. Robert Slimon has also done equally good work in the Upper Silurian rocks of the Ludlow series of the Lesmahagow district, and many of his finest specimens, in almost perfect condition, are to be seen in the British Museum.

Mr. DAIRON stated that an examination of the Moffat shales shows them to be so twisted and contorted, and with so many joints and faults which break the layers into such small slabs, that it is very doubtful if more than fragments of the larger species of these crustacean remains can be ever obtained. If specimens of the smaller species, such as *Pterygotus minor*, are found in the Moffat beds, it is possible they may be secured in a more perfect and complete condition.

Mr. Dairon's collection was illustrated by a number of drawings on a large scale, executed by himself.

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SOCIETY'S ROOMS, 207 BATH STREET.

10TH FEBRUARY, 1881.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

Dr. Henry Gray, 15 Newton Terrace, and Mr. James Steel, 41 Gardner Street, were elected Ordinary Members of the Society.

Mr. DANIEL M'MILLAN exhibited a number of Garnets from Shetland, found in Mica-schist, which were said by the Chairman to be the finest specimens of Crystallized Garnets ever brought before the Society.

Mr. ARCHIBALD ROBERTSON, V.P., exhibited a specimen of Garnetiferous Schist from the large boulder discovered and broken up by Mr. Wünsch near Aberfeldy some years ago. The Garnets in it were, however, badly fractured. It also contained Tourmaline or Schorl.

Dr. J. J. DOBBIE, M.A., D.Sc., read a paper entitled "Note on a specimen of altered Dolomitic Limestone from the Cement-stone series of the Ballagan group." [See page 49].

Mr. W. E. KOCH, F.G.S., then read a paper "On Mull and its Leaf-beds" (see page 52), illustrating it with a number of maps, charts, and sections, and a large and fine series of specimens from the igneous rocks and miocene leaf-beds of the island. Also, numerous Tourmalines from Craig-y-chroman, near Bunessan, where they occur in altered Silurian rocks in a vein through mica-schist.

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The SECRETARY announced that the Council had agreed to spend £14, or thereby, on a new bookcase, but that the consent of the Society had to be formally obtained. The Chairman then put the proposal to the vote, and the meeting unanimously signified its assent.

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SOCIETY'S ROOMS, 207 BATH STREET.

10TH MARCH, 1881.

Mr. D. C. GLEN, F.G.S., *Vice-President*, in the Chair.

The CHAIRMAN exhibited a number of specimens, including Crystallized Dolomite, or Bitter Spar; Tertiary Coal from Brora, Sutherlandshire; and Mica-schist, Coal, and Post-pliocene Shells from Cape Katers, Davis Straits, on which he made some explanatory remarks.

Dr. J. R. S. HUNTER, D.Sc., F.R.Ph.S.Edin., &c., *Honorary Member*, then read a paper "On the Silurian Rocks of Logan Water, Lesmahagow" [see page 56], which was illustrated by a splendid series of fossils from the district.

Mr. JOHN YOUNG, F.G.S., V.P., said that he had to congratulate the Society upon the results of recent years' hard work which had been placed before them that evening by their friend, Dr. Hunter. There were now sufficient new and undescribed forms in the "Braidwood" collection to warrant Dr. Henry Woodward in issuing a supplement to his work on the upper Silurian forms on which he was the recognised authority.

Mr. JAMES THOMSON, F.G.S., said that the members should be proud of the magnificent display now placed before them. He thought that the way in which Dr. Hunter had worked out the stratigraphical details was simply admirable. Without them other details were of comparatively small account.

Mr. W. E. KOCH, F.G.S., remarked upon what Dr. Hunter had said as to the shallow-water conditions under which he believed some of the fossiliferous beds mentioned in the paper had been laid down. He himself thought that such conditions were those generally existing in every geological formation of stratified rocks—deep-sea conditions being very rare. He hoped that the remarks made by Mr. A. R. Wallace in his last-published work, "Island Life," had given the death-blow to the deep-sea theory. Mr. Koch also expressed his hope that great caution would be exercised in future in the creation of new genera and species amongst the smaller organisms, as they were probably, in many instances, only the larval or young forms of other or larger species of crustacea.

Mr. D. FORSYTH spoke of the great labour which must have been undertaken to bring together even that fragment of the "Braidwood" collection which they had seen; and proposed that the meeting should award Dr. Hunter a hearty vote of thanks for the trouble he had taken on the Society's behalf, and this was unanimously agreed to.

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SOCIETY'S ROOMS, 207 BATH STREET,

14TH APRIL, 1881.

Mr. ARCHIBALD ROBERTSON, *Vice-President*, in the Chair.

Mr. Thomas M. Barr, C.E., was elected a Life Member of the Society.

Messrs. P. W. Armour, Jane Villa, Pollokshields; George Wilson, 95 Stirling Road; T. B. Robinson, 339 Sauchiehall Street; Alexander M'Kenzie, Rosebank Street, Cambuslang; John Reid, jun., Loanhead House, Baillieston; David Wotherspoon, 3 Govan Street, Gorbals; W. A. Dobbie, Bearsden; John Dick, 196 Paisley Road; James Muirhead, The Forge, Crossmyloof, were elected Ordinary Members of the Society.

Mr. JAMES COUTTS exhibited a further selection from the collection of Mr. Andrew Paton, *cor. mem.*, East Kilbride. (1) A spine of *Oracanthus minor*, which deserved attention from the excellent state of preservation of its external surface. It has only been met with once or twice in the East Kilbride beds, and but rarely elsewhere. In the Catalogue of Western Scottish fossils two species are recorded, both from the Beith district; but Professor M'Coy is inclined to believe that they are both the same, their ornamentation being identical. (2) A tail segment of *Eoscorpius*, from the cement-limestone. This species has been obtained in three other localities, all in Lanarkshire—two at Gillfoot by Dr. Rankin, and one at Capelrig by Mr. John Young. From the fragmentary nature of the specimens there is still some doubt as to their identification; and it is to be hoped that more perfect ones may yet be met with. (3) A small slab of shale containing numerous fragments of rib-like bones, which may belong either to fish or to some species of amphibia, but there do not appear to be any scales associated with them. (4) Fine specimens of *Dithyrocaris granulata* and *D. tricornis*, being two of the nine known species of the genus. Three of these nine are new, having been lately found at East Kilbride—*D. granulata*, *D. ovalis*, and *D. glabra*. (5) Rib bone of an amphibian reptile, not identified. (6) Scale of *Rhizodus Hibberti*. (7) *Cypricardia*. (8) *Pteronites*. (9) *Trochus*, sp. nov. (10) A plant impression on black shale, not identified.

Mr. COUTTS said further that at last November meeting (1880) he had exhibited an enlarged drawing and specimens of a crustacean from the cement-limestone, but the specimens were so crushed that the true figure could not be determined. He was now, however, enabled to exhibit other specimens of the same organisms, in which the characteristic features could be readily made out, and which show them to belong to an entirely new species not yet named.

Mr. DAVID ROBERTSON, F.L.S., F.G.S., read an exhaustive paper "On the Post-tertiary Beds of Garvel Park, Greenock" [see page 1], which was illustrated by sectional maps, and by a large suite of specimens.

Mr. MURDOCH read a short paper, forwarded by Mr. E. A. Wünsch, F.G.S., entitled "Description of an Erratic Boulder on the Highland Railway" [see page 63].

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A number of the members spoke on the subject of Mr. Wünsch's paper, but no one coincided with his views as to the non-eruptive nature of granite; and Mr. John Young, F.G.S., said that Mr. Wünsch should read Professor Judd's remarks upon the Mull, Arran, and Mourne Mountain granites in the *Quarterly Journal* of the Geological Society, the aqueous theory of the origin of granite being now generally abandoned by geological authorities.

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SOCIETY'S ROOMS, 207 BATH STREET,
5TH MAY, 1881.

Mr. D. C. GLEN, F.G.S., *Vice-President*, in the Chair.

Mr. E. A. Wünsch, F.G.S., was elected an Honorary Associate; Mr. D. C. Glen, F.G.S., V.P., was elected a Life Member; and Mr. E. E. Doddrell, West George Street, was elected an Ordinary Member of the Society.

The CHAIRMAN exhibited a number of specimens of rare and interesting minerals from the "Bell Collection," lately dispersed in Glasgow, comprising specimens of Native Copper, Copper with Silver, Lapis Lazuli, Manganite, Dioptase, Sulphide of Zinc, Malachite, &c., and gave some details regarding their occurrence and rarity.

Mr. THOMAS STEWART read a paper entitled "Sketch of the Geology of Part of the Mainland, Shetland" [see page 66].

Mr. JAMES THOMSON, F.G.S., said he could not agree with Mr. Stewart in his statement that the age of the metamorphic rocks of Scotland was unknown. For his own part, he had no doubt that those of Shetland should be correlated with other similar rocks of the North of Scotland, such as those of Loch Broom, in Harris. He congratulated the Society on the reception from a young member of such a valuable paper, and one which showed a considerable amount of original thought and research.

Mr. CLEGHORN, of Wick (a visitor), asked leave to make a few remarks, as he was personally acquainted with the ground described by Mr. Stewart. He did not believe that there was true Boulder-clay in Shetland; at least not such as corresponds with that of the north-east of Scotland, and which contains broken shells to a considerable extent.

Several other members spoke in terms of commendation of Mr. Stewart's paper. It was remarked that the Boulder-clay of the West of Scotland was almost, if not quite, unfossiliferous, so far as known. It was hoped that Mr. Stewart would have time and opportunity to follow up his past researches, and to lay the results before the Society in a future paper.

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SOCIETY'S ROOMS, 207 BATH STRERT,
19TH MAY, 1881.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

Mr. W. H. Glen, 14 Annfield Place, was elected an Ordinary Member of the Society.

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Mr. MURDOCH referred to the publication of a new geological work by their esteemed late Secretary, Mr. Dugald Bell, entitled "Among the Rocks around Glasgow," and highly commended it as an accurate and trustworthy guide to the geology of the West of Scotland, with a recommendation to the members who had not yet subscribed to do so. The Chairman added some words of strong eulogium of Mr. Bell's work, remarking that all who were fond of rambles round the district, and who wished to acquire a knowledge of the local geology, could not put themselves into better hands.

The CHAIRMAN (Mr. Young) exhibited a number of fine specimens of *Ulodendron*, *Halonia*, *Lyginodendron*, and other plant remains, from the Addiewell Oil Shales, and which had lately been presented to the Hunterian Museum by Mr. Alexander Smith.

Mr. DAVID ROBERTSON, F.L.S., F.G.S., exhibited a large series of specimens of Mosses from the Post-tertiary clay-beds of Garvel Park, Greenock. No less than 37 species had already been identified, while probably as many more remained unnamed. Some of the specimens were in such a perfect state of preservation as still to retain their fruit. (For Mr. Robertson's remarks and list see his paper on Garvel Park, page 1).

Mr. JAMES COUTTS exhibited a Fossil Fern and some bodies resembling Seeds of Plants, found in the cement-limestone series of East Kilbride, and from the collection of Mr. Andrew Paton, *cor. mem.*

Mr. DAVID FORSYTH, M.A., read a paper entitled "Notes on the Silurian Rocks of the Muirkirk District," illustrated by maps, sections, and a collection of the characteristic fossils of the district [see page 74].

Several members spoke on various points in Mr. Forsyth's paper, and after a hearty vote of thanks the Society adjourned till the opening of the 24th session in October.

## PROCEEDINGS FOR SESSION 1881-82.

### (24TH SESSION.)

SOCIETY'S ROOMS, 207 BATH STREET,
13TH OCTOBER, 1881.

Mr. ARCHIBALD ROBERTSON, *Vice-President*, in the Chair.

Mr. ROBERT GALT, jun., 58 West Regent Street, was elected an Ordinary Member of the Society.

Mr. JAMES COUTTS exhibited a series of specimens from the cement-limestones of East Kilbride, and from the collection of Mr. A. Paton, *cor. mem.*, and said that, having during the past session brought under the notice of the Society various species of *Dithyrocaris*, he had now the pleasure of calling attention to two species of the same genus, apparently undescribed. (1.) The first was a very minute form, and perhaps the handsomest species yet found, the examples being very perfect. The

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second was much larger, and, though the specimens are somewhat imperfect, they show characters sufficient to mark them as a distinct species. He also exhibited the following from the same locality:—(2) Nine fossil seeds, most likely belonging to *Trigonocarpum*. (3) A portion of a stem, probably of a species of *Volkmania*. Better specimens, which have since occurred in the same beds, are now in the Greenock Museum. (4) A specimen of *Posidonymia*, probably allied to *P. corrugata*, but which, as it is much larger than named specimens of that species, may possibly be different. (5) A stem of *Lepidodendron* and several other plant remains, with the markings well preserved.

Mr. JOHN YOUNG, F.G.S., V.P., proposed that a hearty vote of thanks be awarded to Mr. Paton for his kindness in allowing so many interesting specimens from his collection to be laid before the Society, through Mr. Coutts, on this and on previous occasions. Mr. Paton, in the course of his researches, had brought to light at least three species of phyllopod crustaceans new to science, and probably some of the forms now exhibited belonged to the same group. The meeting unanimously passed a vote of thanks, which the Secretary was instructed to convey to Mr. Paton.

Mr. JOHN HORNE, F.R.S.E., F.G.S., &c., of H.M. Geological Survey of Scotland, then read a paper on "The Volcanic History of the Old Red Sandstone Period, North of the Grampians." [See page 77.] The paper was illustrated by a large series of coloured drawings of rock scenery; also maps and diagrams of microscopic rock-sections.

The Chairman, Mr. John Young, F.G.S., Mr. James Thomson, F.G.S., Mr. Thomas Stewart, and other members, spoke on the subject, and a cordial vote of thanks was awarded to Mr. Horne for his interesting communication.

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SOCIETY'S ROOMS, 207 BATH STREET,

ANNUAL GENERAL BUSINESS MEETING, 10TH NOVEMBER, 1881.

Mr. D. C. GLEN, F.G.S., *Vice-President*, in the Chair.

Mr. David T. Maclay, 3 Woodlands Terrace, and Mr. W. J. Brooks, 114 Bath Street, were elected Ordinary Members of the Society.

Mr. MURDOCH, Hon. Secretary, then read the Report of the Council for the past year, as follows:—

As is customary at the beginning of a new session, the Council have the pleasure of submitting to the members their annual review of the state of the Society and its business for the past year. On the present occasion they do so with the more satisfaction that upon the whole the aspect is a decidedly favourable one.

The MEMBERSHIP has been, nominally at least, kept up to its average, but as your Treasurer will explain, there has been some backwardness on the part of a certain percentage of members to pay their subscriptions. In too many instances, when the collector called for payment he was told that the member has resigned, although no notice to that effect had been received by either the Treasurer or the Secretary.

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It is under the consideration of the Council how best to remedy such a state of matters in the future. One thing that might be reasonably asked is that the proposer and seconder of any member who is in arrear of his subscription should take upon themselves the duty of finding out the real causes of non-payment. A new form of application for admission to the Society has been prepared by the Secretary, which stipulates that the candidate agrees, upon election, to conform to the rules of the Society, and that should he wish at any time to resign his connection with the Society, he binds himself to send in a written notice of resignation to the Secretary. Before any candidate can be proposed for election the Council have agreed that this form must be signed by him personally, as well as by his proposer and seconder.

The number of members now upon the roll is somewhat over 200. By a little personal exertion on the part of members, this number might be easily increased, especially by the newer members, whose friends are not so likely to have been asked to join the Society as those of the older members.

During the year two Life Members have been added to the roll, and in this part of the field there is also room for extended operations. It should not be forgotten that the subscriptions from this source have always been carefully set apart from the general funds of the Society, and that they are now invested on good security, yielding a small annual income, equal to the yearly subscriptions of about ten members.

The MEETINGS of the winter session were nine in number, and were usually well attended. A considerable variety of material was brought up for exhibition, and many interesting and valuable papers were read and discussed. Amongst these latter may be mentioned the late Mr. Arthur Pratt's "Notes on the Igneous Rocks of the Kilmalcolm District;" Mr. W. E. Koch's "Account of a Visit to Mull and its Leaf-beds;" Mr. David Robertson's paper "On the Post-tertiary Beds of Garvel Park, Greenock;" and Dr. Hunter's paper "On the Silurian Rocks of Logan Water."

No special meetings were held during the session, and the President, Sir William Thomson, did not deliver an address, as it was hoped he would have been able to spare time to do.

THE EXCURSIONS arranged for the Spring and early Summer were as follows:—

| | | | |
|---|---|---|---|
| *April* 14 | —Garvel Park, . | conducted by | Mr. DAVID ROBERTSON, F.G.S. |
| ,, 30 | —Kerrsland Glen, . | ,, | Mr. ROBERT CRAIG. |
| *May* 14 | —Gourock, . . | ,, | Mr. DANIEL WILSON. |
| ,, 26 | (Queen's Birthday Annual Pic-Nic).—Craignethan, | ,, | Dr. J. R. S. HUNTER, F. R. Ph. S. Ed. |
| ,, 28 | —Corrieburn, . | ,, | Mr. JOHN YOUNG, F.G.S. |
| *June* 11 | —Kilmalcolm, . . | ,, | Mr. ARTHUR PRATT. |

These were all well, and in some cases largely, attended, except the last on the list, that to Kilmalcolm, which, out of respect to Mr. Pratt, did not take place, when it became known to the members that he was suffering from a severe, and what afterwards proved to be a fatal, illness.

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The Queen's Birthday excursion was taken to Craignethan, the scene of more than one very successful gathering on former similar occasions, and was again conducted by the Society's friend and honorary member, Dr. J. R. S. Hunter of Daleville, who kindly prepared and read to the assemblage a long and interesting paper upon various historical points connected with the famous old castle of Tillietudlem and its neighbourhood.

An extra excursion not announced upon the card for the season was that afterwards arranged to be taken jointly with the members of the Edinburgh Geological Society to Bathgate, upon the 18th June, and which was conducted by one of that Society's Vice-Presidents, Mr. Henry Cadell. Favoured with agreeable weather and taken to a most interesting district of country, this trip was pronounced by those who had the good fortune to assist at it to be one of the most enjoyable of the season, and hopes were freely expressed that similar joint excursions of the two Societies would long continue to be annually arranged. It ended at Linlithgow, where a merry party recruited exhausted nature at the well-spread board of the Star and Garter.

The thanks of the members are justly due to all the gentlemen who exerted themselves in conducting the various excursions.

The LIBRARY has now been provided with ample accommodation for years to come in the form of a new and handsome book-case. It is expected that shortly the books will be put into thorough working order, and that a new catalogue will be issued. Exchanges continue to be made with many of the leading scientific societies both at home and abroad.

Of the TRANSACTIONS a new part (part ii. vol. 6) is now in the printer's hands and will shortly be issued to members. The next part will be commenced immediately on the completion of this one; and it is expected that by another session the publication of the Society's transactions and proceedings will be brought up to date.

The change in the place of meeting, from Anderson's College to the Rooms in which the Society now meets, has proved, so far as is known, to be very satisfactory to the members generally. The accommodation allotted to the Society is both handsome and commodious, while every facility has been given by the House Committee of the proprietory societies and by their officer, Mr. Thomas Napier, for the conducting of the business.

The saddest part of this Report yet remains—to note and mourn the ravages which death has made in the ranks of the members. Amongst those whose absence from this cause we have to deplore must be named Mr. Arthur Pratt, one of the Society's oldest, and one of its best friends. A native of Fifeshire, Mr. Pratt came to Glasgow in early life, and by hard study, when the cares of business permitted, he acquired an extensive and accurate knowledge of both geology and natural history. He became a member in the early days of the Society, and so was one of the comparative few who helped to pioneer it through its early struggles. Whilst taking an interest in all branches of geological investigation, Mr. Pratt for a number of years past turned his attention almost exclusively to the microscopic examination of the igneous rocks. He was the first member of the Society

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to do so, and was a most untiring worker in the field, having prepared with his own hands, and by a process improved by himself, many hundreds of transparent rock-sections. One feature in Mr. Pratt's character which must be mentioned was the readiness with which he gave assistance to beginners in the same line of study as his own favourite pursuit, and there are now many who owe their first start in this fascinating work to his kindly advice and assistance. Whilst an enthusiast in geology Mr. Pratt was at the same time one of the most modest and unassuming of men, but his retiring worth had come to be well known and appreciated by his fellow-members, amongst whom therefore there is no doubt that his memory will be long and justly esteemed.

The Treasurer then read his annual financial statement, as follows :—

| | | | | | |
|---|---|---|---|---|---|
| The funds of the Society last year, exclusive of Publications, amounted to . . . . . | | | | £225 | 3 5 |
| Less the Liabilities it then owed, . . . . . | | | | 6 | 7 1 |
| Showing nett Stock, . . . . . | | | | £218 | 16 4 |
| This year the Society's funds and property, exclusive as above, are valued at . . . . . | | | | £292 | 3 5 |
| Less Martinmas Rent, . . . . . | £5 | 0 | 0 | | |
| Printer's Account, . . . . . | 8 | 9 | 1 | | |
| Account for Painting Bookcase, . . . | 1 | 10 | 0 | | |
| | | | | 14 | 19 1 |
| Showing nett Stock, . . . . . | | | | £277 | 4 4 |

—from which it will be seen that the Society is steadily advancing in the accumulation of funds.

The Treasurer reported a year ago that he had recovered the Subscriptions of 189 members, including 16 new ones, with arrears from 11. He reports this year that he has recovered subscriptions from 177 members, including 17 new ones, with arrears from 2. A good many resignations have taken place during the year, but the effect on the income of the Society does not appear to have told very heavily, seeing the funds of the Society have advanced by nearly £60. The printing last year was £64 3s., the ordinary expenses £37 9s., and new books £7 17s. 5d.—in all, £109 9s. 5d. This year the printing, so far as paid, has amounted to £7 15s. 3d.; and ordinary expenses to £26 6s. 10d.—in all, £34 2s. 1d. Our expenditure is therefore upwards of £75 less than last year. Of course the Bookcase is not considered to be expenditure, being classed as property in hand. The total income last year was £112 2s. 8d, and this year £101 2s. 1d., but though the income is down £11, the expenditure is down £75. On the whole therefore the Treasurer has a favourable account to give of the Society's financial affairs.

JOHN WIGHT, Treasurer.

[The Treasurer's Financial Abstract will be found at page 224.]

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Both these Reports were then formally approved of.

Mr. JOHN YOUNG, F.G.S., proposed a vote of thanks to the retiring Librarian, Mr. Richard Neilson, for his services to the Society in past years; also to the Treasurer, Librarian, Hon. Secretary, and Joint-Secretary, for the time they had spent and the trouble they had taken in conducting the Society's business, and this was cordially agreed to.

Mr. MAYER proposed, and the meeting agreed, that an extract from the Report of the Council, referring to the late Mr. Arthur Pratt, should be sent to his widow by the Secretary.

The vacancies in the list of office-bearers were then filled up as follows:—Mr. Dugald Bell, Vice-President; Mr. D. C. Glen, F.G.S., Rev. W. Williams, Dr. J. J. Dobbie, M.A., D.Sc., and Mr. James Coutts, Members of Council; Mr. John Wight, C.A., Treasurer; Mr. Joseph Somerville, Librarian; Mr. James B. Murdoch, Hon. Secretary; Mr. Gavin Pratt, Joint-Secretary.

Messrs. Robert Mason and John Robertson were re-elected auditors for the ensuing year.

Mr. D. C. GLEN read Notes on the Origin and First Year's Work of the Society, communicated by Mr. Thomas M. Barr, C.E. (These notes were incorporated with the extended paper read by Mr. Barr at a subsequent meeting, see page 97).

The CHAIRMAN proposed that the thanks of the Society should be awarded to Mr. Barr for his highly interesting notes, with the expression of a hope that he would extend them and continue the history of the Society to a later date, which, as one of the original founders of the Society, he was well qualified to do.

Mr. JOHN MAYER, F.C.S., seconded the motion, and in doing so paid a warm tribute to the enthusiasm of the late Dr. Taylor in the cause of geological science, and testified to the impetus which he gave it by his courses of lectures in the Andersonian University.

Mr. JAMES WHITE read a paper entitled "Remarks upon the Geology of the Isle of Man, with some specimens of its Minerals and Fossils" [see page 81].

Mr. JOHN YOUNG, F.G.S., and the CHAIRMAN made some remarks upon the subject, complimenting Mr. White upon the manner in which he had treated it.

Rev. Mr. WILLIAMS referred to the late Mr. Clifton Ward, F.G.S., who had thoroughly studied the geology of the Isle of Man, and whose death was a real loss to the cause of geological science.

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SOCIETY'S ROOMS, 207 BATH STREET,
8TH DECEMBER, 1881.

Mr. ARCHIBALD ROBERTSON, *Vice-President*, in the chair.

Sir William Thomson was unanimously re-elected President of the Society.

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Mr. Robert Turner, 122 Hospital Street, was elected an ordinary member of the Society.

Mr. DAVID FORSYTH, M.A., exhibited specimens of *Oldhamia radiata*, which he had obtained from the Lower Cambrian strata of Bray Head, Co. Wicklow, and made some remarks upon them, as did also Mr. John Young, F.G.S.

Mr. JOHN KIRSOP, F.S.A.Scot., exhibited a variety of specimens of interest, including Minerals from Colorado and a species of Homocercal Fish from the Rocky Mountains in a fine state of preservation.

Mr. JAMES DAIRON exhibited a small collection of fossils from the Gault, which he had made on a recent trip he had taken to the neighbourhood of Folkstone, where the strata are well exposed. Mr. Dairon at some length explained the position of the beds, and described their contained organisms.

Mr. JAMES STEWART of Williamwood read a paper entitled "Notes on the Limestones in the parishes of Cathcart and Eastwood, Renfrewshire" (see page 158), illustrating his remarks by carefully prepared diagrams of the bore sections and by a coloured map and a section of the district.

Mr. JAMES THOMSON, F.G.S., said that he was much pleased to hear the outcome of Mr. Stewart's investigations, as he had heard doubts expressed by Mr. Cunningham as to the correctness of the survey map many years ago.

Mr. JOHN YOUNG, F.G.S., said he thought that Mr. Stewart had clearly proved his case, and expressed a hope that the paper, with its accompanying illustrations, would be given in full in the *Transactions*.

Mr. JAMES COUTTS read a paper entitled "Notes on a Carboniferous Selachian Fish from the cement-limestone series of East Kilbride, and now in the collection of Mr. A. Paton, *cor. mem.*" [See page 164].

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SOCIETY'S ROOMS, 207 BATH STREET,
12TH JANUARY, 1882.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

Mr. George A. Mitchell, 67 West Nile Street, was elected an ordinary member of the Society.

Mr. JOSEPH SOMMERVILLE proposed that the sum of £20 of the Society's funds should be applied to library purposes—purchase of books, binding, &c.—and this having been put to the meeting was unanimously agreed to.

Mr. ROBERT CRAIG, Langside, Beith, *cor. mem.*, and the Chairman, exhibited a portion of a Tusk of the Mammoth, *Elephas primigenius*, and a number of Arctic Marine Shells, recently obtained in sinking a pit near Dreghorn, Ayrshire. They stated that these remains were found in a series of muddy sand-beds, resting directly on the Carboniferous strata, at a depth of nearly 80 feet from the surface, and underlying the lower Boulder-clay of the district.

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The portion of the Mammoth tusk found by the pit-sinkers was three feet or more in length, and five inches in diameter. The ivory was in a partially decomposed condition, and being mistaken by the pitmen for a kind of rotted fossil wood, was most unfortunately broken up and scattered about. It was, however, much in the same state of preservation as other tusks of the Mammoth found in similar beds underlying Boulder-clay at Woodhill Quarry, Kilmaurs, in the same district, and now preserved in the Hunterian Museum of the University of Glasgow.

The arctic marine shells, found also in the same pit-shaft as the tusk, and kindly lent for exhibition by Mr. Thomas Shore, at Glengarnock Ironworks, are all of still living species, and correspond generally with similar shells obtained from the sand-bed overlying the Mammoth and Reindeer remains at Kilmaurs. Mr. David Robertson, F.L.S., F.G.S., who had searched some of the sand lying in the crevices of the Dreghorn tusk for microzoa, found it to contain foraminifera, &c.

Further remarks by Messrs. Craig and Young were to the effect that this new and interesting discovery helped to confirm in a very satisfactory manner the evidence they had previously brought before the Society in a former paper [see vol. iii. p. 310]—viz., that the Mammoth remains and Arctic shell-beds at Kilmaurs lay under the lowest Boulder-clay of that district; and that the finding of the same deposits characterised by the same group of organisms in the pit-shaft at Dreghorn, which is nearly three miles from the quarry at Kilmaurs, showed clearly that this group of strata is very persistent under the Boulder-clay over a large tract of country lying within the watershed of the Water of Irvine. The discovery also showed that there is no other lower Boulder-clay, and that the statement made in the Explanation to sheet 22 of the Geological Survey Map (North Ayrshire requires correction of the statement that the Kilmaurs beds, containing Mammoth remains and Arctic shells, form portions of an inter-glacial series of deposits, lying between an upper and a lower Boulder-clay. There is no evidence whatever for this statement, nor even that any deposits, containing similar organisms have ever been met with between Boulder-clay anywhere in this same district of the country. Now that Professor Boyd Dawkins and Dr. Leith Adams admit the Mammoth into their lists of British pre-glacial mammals, they support the former conclusions of Messrs Craig and Young as to the great probability of these Ayrshire deposits being of pre-glacial age, and consequently older than the lower Boulder-clay of Scotland.

Mr. Dugald Bell, Vice-President, made some remarks, followed by Mr. James Thomson, F.G.S., who asked Mr. Craig if he had observed specimens of West Highland rocks in the Boulder-clay above the remains. In his experience the lower Boulder-clay contained boulders of such rocks while the upper Boulder-clay did not, and their presence or non-presence would therefore afford sure evidence as to the true position of the beds in which the Arctic shells had been found. Mr. Craig said that he could not answer the question, but that he had no doubt whatever that it was the true lower Boulder-clay below which the shells lay.



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Mr. ARCHIBALD ROBERTSON, V.P., exhibited a specimen of Orbicular Diorite from the Island of Corsica, which had been sent him by Dr. Leslie Ogilvie of London, with the following notes on its occurrence. Several varieties of Orbicular rocks are found in Corsica, the most remarkable being the Orbicular Granite of Sainte Lucie de Sallano, which is classed amongst the greenstones or hornblendic traps, and is more properly named Orbicular Diorite. It consists of a white basic felspar—probably anorthite—combined with a hornblende which is dark-green in colour, a small quantity of which also enters into the composition of the matrix. The rock has a spheroidal texture and may be described as a collection of spheres in which felspar and hornblende are disposed concentrically, and which are of greater density and hardness than the intervening matrix or enveloping mass. The spheres are nearly all of the same volume, their diameter varying from 30 to 35 millimetres (*i.e.*, about 1¼ inches). But a section of such a sphere will necessarily vary in size according as it is central or tangential. They are not always round, deformity sometimes resulting from mutual pressure. The concentric arrangement is well seen in many of the sections. The peripheral zone is white felspar, and is bounded internally by a narrow green line of hornblende. The hornblende is in excess in the interior of the sphere and appears to form a nucleus. Orbicular Diorite is found in isolated blocks within a small radius in the southern part of Corsica, where syenites and amphibolites are found in abundance. The specimen exhibited was obtained from a rock of only a few yards of surface, forming part of a ravine near the river Fiumicicoli, about four miles from Sallano. The spheres were not equally distributed on the face of this rock, aggregations of these appearing at intervals over the exposed surface. It is probable that the deeper rocks exhibit the same structure, but this is by no means certain.

Mr. JAMES STEEL exhibited a stone hammer, found in March, 1879, on the Brock Water near Darnley, Renfrewshire, and about two miles above the junction of that stream with the Levern. It was found in the digging of a drain at a depth of between 7 and 8 feet from the surface, and lying on the top of Boulder-clay. It is formed of a variety of dolerite, is 7 inches long and 3 inches deep, or at the broadest part 3½ inches, and is pierced by a hole for the insertion of a handle.

Mr. JOHN KIRSOP exhibited a number of polished sections of rocks from Devonshire, and other specimens.

Mr. DAVID ROBERTSON, F.L.S., F.G.S., exhibited a spine of an echinoderm, probably *Echinus Dröbachiensis*, from the Post-tertiary clay-beds at Garvel Park, Greenock. It has had the cup-shaped part of its ball-and-socket joint removed by long maceration in the surrounding clay, and this removal has brought into view a small tubercle with a little depression at the end. This small tubercle and cup hold the same relation to the base of the spine as the removed portion did, and appear to be a repetition of it. But it is not to be supposed that a restoration of such a joint in the spine could ever have been of any use to the echinoderm in its present form. If ever,

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therefore, a solution of its use is arrived at, it will probably be in the remote history of the ancestors of the species.

Mr. ROBERT CRAIG, Langside, Beith, *cor. mem.*, then read a paper "On the Fossiliferous Bands between the Upper and Lower Limestones in the Dalry District, Ayrshire." [See page 86.]

Mr. JAMES THOMSON, F.G.S., congratulated the Society on the reception of Mr. Craig's paper, and made some observations regarding one or two points in it with which he did not see his way to agree.

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SOCIETY'S ROOMS, 207 BATH STREET.

9TH FEBRUARY, 1882.

Mr. DUGALD BELL, *Vice-President*, in the Chair.

Mr. JAMES C. CHRISTIE exhibited a large Amethyst which he had obtained in Germany, and which contained within the mass a Pseudomorph, and gave some explanations as to a probable mode of accounting for the occurrence.

Mr. JOHN KIRSOP, F.S.A. Scot., exhibited a variety of specimens, including (1) Fossil Plant Remains from the Carboniferous series, (2) Fossils from Spanish Copper Mines, (3) Nodule of Red Flinty Septariated Ironstone from North Berwick, having a remarkable natural resemblance to a human skull.

Dr. J. R. M. ROBERTSON read a long and interesting paper upon "The Bismuth and Stanniferous Deposits of Australia," illustrating it by a large suite of specimens, and by maps and diagrams.

Dr. J. J. DOBBIE made some remarks upon the subject of Dr. Robertson's paper, saying that to him belonged the merit of first describing the occurrence there of Native Bismuth, and that consequently this paper would be of interest to mineralogists all over the world. He believed that if the supply of Bismuth was largely increased and the price lowered, it would probably come into use for new industrial purposes. He should like to know if wolfram occurred in connection with the other minerals mentioned.

Dr. ROBERTSON said that so far as he knew it did not.

Mr. JOHN YOUNG said that it had never before been pointed out that Oxide of Bismuth occurred to such an extent in connection with Bismuth itself. So far as his experience went the specimens of Native Crystallised Bismuth shown by Dr. Robertson were the purest examples that had ever been seen.

Mr. D. C. GLEN, F.G.S., Mr. JOHN MAYER, F.C.S., and Mr. JAMES C. CHRISTIE also spoke, and a hearty vote of thanks was awarded to Dr. Robertson for his kindness in bringing the subject before the Society.

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SOCIETY'S ROOMS, 207 BATH STREET.

2ND MARCH, 1882.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

Messrs. John Carswell, 6 Eildon Villas, Mount Florida, and James

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Anderson, 76 Howard Street, were elected Ordinary Members of the Society.

Dr. J. J. DOBBIE exhibited specimens of a variety of Saponite found in the Dolerite of Cathkin Quarry by Mr. Walter Burns, and said—The specimens now before the meeting belong to that large class of minerals which are composed essentially of silicate of magnesia and water. They are of a deep chocolate-brown colour, have a waxy lustre, and well-marked conchoidal fracture, and the soapy feel characteristic of all hydrated silicates of magnesia. Their specific gravity is about 2·214, and their hardness about 2·0. When thrown into water they split up into small fragments. Numerous hard particles of some foreign mineral matter scattered through the specimens may either represent the remains of the mineral, whose decomposition has given rise to the Saponite, or more probably they are minute crystals or crystallites of some other mineral. When treated with hydrochloric acid the Saponite effervesces freely and dissolves, leaving a residue of insoluble silica.

Three analyses of the mineral gave the following results :—

| | I. | II. | III. |
|---|---|---|---|
| $SiO_2$ | 39·98 | 39·38 | 40·44 |
| $Fe_2O_3$ | 6·92 | 3·79 | ·44 |
| FeO | 8·71 | 9·45 | 13·54 |
| $Al_2O_3$ | 4·20 | 6·70 | 4·94 |
| CaO | 2·83 | 1·89 | 3·05 |
| MgO | 18·62 | 20·39 | 19·85 |
| $H_2O$ | 17·28 | 17·11 | 17·24 |
| $CO_2$ | ·40 | ·14 | ·4 |
| | 98·94 | 98·85 | 99·90 |

Prof. Heddle gives as the mean of the analysis of 13 specimens of Saponite from different localities the following numbers :—

| | |
|---|---|
| $SiO_2$ | 40·63 |
| $Al_2O_3$ | 7·18 |
| $Fe_2O_3$ | 3·96 |
| FeO | 2·38 |
| CaO | 2·14 |
| MgO | 21·43 |
| $H_2O$ | 21·76 |
| | 99·48 |

These numbers show that as regards the percentage of silica and magnesia—the two most important constituents—the specimens from Cathkin Quarry correspond almost exactly with the ordinary varieties of Saponite, the chief difference being in the amount of water and of protoxide of iron. The Cathkin specimens also differ considerably in physical properties from any hitherto described variety of Saponite.

Mr. YOUNG exhibited specimens of Pectolite, and said—The specimens of Pectolite which I exhibit were obtained by Mr. James Duncan of

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Twechar, Kilsyth, and were found in the dolerite of Auchensterry Quarry there. They are the largest and finest examples I have ever seen from Western Scotland, in which Pectolite is of somewhat rare occurrence. The mineral has been long known to occur at Auchensterry, but very irregularly. On some of the excursions to that district by members of the Society in former years, very thin veins were found, but on other occasions not a trace of it could be seen. In the autumn of last year the quarrymen struck a vein which varied in thickness from 1 to 2 inches, and in which there were one or two drusy cavities in which the mineral is seen to terminate in groups or segregations of finely acicular crystals. In these also the crystals of Pectolite are sometimes coated with small clear crystals of what is believed to be harmotome, and small crystallised tufts of a black mineral, probably tourmaline or schorl. Pectolite belongs to the hydrous silicate group, but not to that section in which the zeolites are placed. It has been known under several names, such as Stellite, Osmelith, Wollastonite, and Ratholite, the latter being from Ratho near Edinburgh, where it occurs in a similar dolerite to that of Auchensterry. It is of a fine greyish-white colour, and on the cleaved face shows a dense, silky, compact structure, with a fibrous radiated arrangement of the crystals. Its hardness is five in the scale, and it is very tough. In chemical composition it is said to be, Si. 52·74, Al. 0·67, Fe. 1·20, Mg. 1·52, Ca. 31·68, Na. 9·60, H. 2·00, Total 99·44. According to Dana it has not been recorded from many stations over the world, and of the twelve localities he mentions, seven are in Scotland.

Dr. J. R. S. HUNTER of Braidwood, *Hon. Mem.*, then read a paper entitled The Geology and Palæontology of Bankend, Bellfield, and Coalburn, Lesmahagow [see page 143], which was illustrated by a splendid series of fossils from the strata of the districts under review.

The Chairman and Mr. David Forsyth, A.M., both spoke on the subject of Dr. Hunter's paper.

Mr. JAMES THOMSON, F.G.S., called in question the accuracy of the statement made by Dr. Hunter, that strata belonging to the upper coal measures had been found in the Douglas district. The author in reply said that all he had brought forward was the result of personal investigation, and that he had no doubt of the correctness of his assertions as to the occurrence of the upper coal measures.

A cordial vote of thanks was then awarded to Dr. Hunter for his paper and specimens.

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SOCIETY'S ROOMS, 207 BATH STREET,

13TH APRIL, 1882.

Mr. ARCHIBALD ROBERTSON, *Vice-President*, in the Chair.

Mr. John Brand, 81 Gloucester Street, was elected an ordinary member of the Society.

Mr. JOHN YOUNG, F.G.S., V.P., proposed the following motion:—"That the meeting instruct the Secretary to record in the minutes the loss the

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Society has sustained through the death of Dr. Daniel Reid Rankin of Carluke, whom the Society did itself the honour of placing on the list of its corresponding members in 1867. Also, that the Secretary be instructed to write to the deceased gentleman's brother, with an extract from the minutes to the same effect. Also, that a notice be prepared for insertion in the *Transactions* of the Society, recording Dr. Rankin's researches into the Geology and Palæontology of his native parish of Carluke, these researches having extended over a period of not less than fifty years." This motion was seconded by Mr. D. C. Glen, F.G.S., and unanimously agreed to.

Mr. JOHN KIRSOP, F.S.A. Scot., exhibited a variety of interesting specimens including (1) Minerals from Wales and from Elba, (2) a recent Concretionary slab from Cardross Bank on the Clyde, (3) an Ammonite, about 18 inches in diameter, from the West of England, (4) a number of Palæontological Plates, including many from the celebrated *Poissons Fossiles* of Agassiz.

Mr. JAMES C. CHRISTIE exhibited a series of specimens of Fossil Fish which he had brought last summer from Sernfthal, Glarus, Switzerland. Mr. Christie explained the mode of their occurrence in the slate rocks of the locality, which was one that had been brought into sad prominence since the date of his visit, from the great landslip which caused such an enormous loss of life.

Mr. THOMAS M. BARR, M. Inst. C.E., Perth, then read a paper, an extension of one he had previously given to the Society, entitled "Notes on the Origin and Early History of the Geological Society of Glasgow." [See page 97.]

The CHAIRMAN, Mr. JAMES THOMSON, F.G.S., Mr. DUGALD BELL, Mr. JOHN YOUNG, F.G.S., and Mr. KIRKLAND (the latter one of the original members and the first Secretary of the Society), spoke on the subject of Mr. Barr's paper, after which a hearty vote of thanks was awarded to him for his interesting and valuable account of the Society's early days. The hope was expressed that on a future occasion the account would be brought up to a more recent date.

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SOCIETY'S ROOMS, 207 BATH STREET,

4TH MAY, 1882.

Mr. DUGALD BELL, *Vice-President*, in the Chair.

Mr. JAMES COUTTS exhibited specimens of Crustacean remains from the cement-limestone shales of East Kilbride, and in the collection of Mr. A. Paton, *cor. mem.* Amongst them were several organisms which had not as yet been thoroughly identified, but which were believed to belong to new species of *Anthrapalæmon*, *Pygocephalus*, and *Eoscorpius*. Mr. John Young, F.G.S., also made some remarks on the specimens.

The Chairman (Mr. Bell) exhibited specimens of Fossils from the Silurian system of Canada. These had been forwarded to him by Messrs. Andrew Neil and William Turnbull of Hamilton, Ontario, and he gave some parti-

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culars regarding the rock formations of the Dominion, which he illustrated by a map and diagram.

Several members remarked upon the specimens brought forward by Mr. Bell. Mr. Dairon said that *Dictyonema*, one of the fossils in the collection, was found in both the Girvan and Moffat strata, and most plentifully in the former at the Penwhapple Burn.

Mr. JOHN YOUNG, F.G.S., V.P., read a paper by Mr. D. C. Glen, F.G.S., and himself, entitled, "Notes on the late Excursion of the Society to Cathkin, with illustrative specimens of the Rocks and Minerals." [See page 166.]

Remarks on the subject were made by Mr. James C. Christie and others.

The Chairman (Mr. Bell) read a short paper entitled, "Notes on a large Boulder of Mica-schist near Inveruglas, Loch Lomond." [See page 172.]

Rev. Mr. WILLIAMS, Mr. JOHN YOUNG, and others, having made some remarks on the interesting subject of ice-action in the transport of large masses of rock, a cordial vote of thanks was awarded to Mr. Bell and to Mr. Young for their papers.

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SOCIETY'S ROOMS, 207 BATH STREET,

18TH MAY, 1882.

Mr. ARCHIBALD ROBERTSON, *Vice-President*, in the Chair.

Messrs. JOHN YOUNG, F.G.S., and ROBERT MASON exhibited a series of specimens of *Rhabdomeson* and *Fenestella* from the limestones of Laigh Baidland, Dalry, some explanatory remarks upon them being made by Mr. Young.

Mr. JOSEPH SOMMERVILLE exhibited, in illustration of the fossil forms found by Messrs. Young and Mason, living specimens of one of the recent polyzoa, *Plumatella repens*.

Mr. D. C. GLEN, F.G.S., exhibited a Pseudomorph after Prehnite from Boyleston Quarry, Barrhead, also several other minerals and rock specimens from various localities.

Mr. MURDOCH exhibited a splendid specimen of a Stone Axe or Celt lately found in the course of draining operations on the estate of Mr. J. J. Mowbray of Naemoor, near Rumbling Bridge, Kinross-shire. The axe, which was found in the bed of an old loch or pond, and in close proximity to slabs of charred wood, was formed of a finely-grained felstone, of a variety which Prof. Heddle of St. Andrews thinks is not found on the mainland of Scotland. The axe was 13 inches in length, and weighed over 7 lbs., its edges being perfectly sharp as when first made.

Mr. JAMES C. CHRISTIE spoke of the reported discovery of organic matter in meteorites, and said he thought suspicion was thrown upon the assertions, from the fact that the "discoverer" was Dr. Hahn, no doubt the same person who, about two years ago, made another "discovery," that

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*Eozoon Canadense* was the remains of Algae, and which turned out to be quite a fabrication.

Mr. JAMES DAIRON read a short paper on "The Life History of the Graptolidae, including the mode of their reproduction and development, with special reference to the genus *Monograptus*" [see page 176] and illustrated it by drawings, and a number of specimens of the group from Moffatdale.

Mr. JOHN YOUNG, F.G.S., V.P., read a paper "On the External Characters which distinguish *Fenestella plebeia* of M'Coy, from *F. tuberculo-carinata* of Etheridge, jun." [See page 182.]

After a few remarks by the Chairman, the Society adjourned till the opening of the Twenty-Fifth Session in October *proximo*.

## RECORDS OF EXCURSIONS.

### CRAIGNETHAN (TILLIETUDLEM).

#### QUEEN'S BIRTHDAY PIC-NIC EXCURSION, 26TH MAY, 1882.

On this occasion the Members of the Geological Society of Glasgow, with their friends, held their annual outdoor Queen's birth-day gathering, which in the course of years has come to be looked upon as an event without which the excursion programme would be seriously incomplete. The rain-storm of Wednesday and the gloomy morning doubtless had their influence in preventing many from joining the excursion who would otherwise have done so. Notwithstanding, a goodly party assembled on the platform of the Central Station, and were sent on their way, along with several other pleasure parties, direct to the scene of the day's outing—Tillietudlem Castle—in a special train, which had been kindly placed at their service by the authorities of the Caledonian Railway Company. Many had been the glances at the barometer in the early morning, and as frequent during the journey were the opinions expressed by the weather-wise—or otherwise—as to the probable result of the indecision shown by the clerk of the weather; but by slow degrees all doubt was dispelled, and it was realised even by the most faint-hearted that not only was the day to be fine but one absolutely perfect for excursion purposes. Never did the young spring foliage look more beautiful than as it presented itself to the admiring eyes of the excursionists, when, after leaving the arrival station, they descended to the terraced slope on which stand the ruins of the venerable castle of Craignethan—perhaps better known by its "Old Mortality" name of "Tillietudlem." When the party reached the quadrangle, Mr. John Young, F.G.S., vice-president, announced the orders of the day, and in a few eulogistic words introduced the conductor for the occasion, Dr. John R. S. Hunter of Braidwood, Carluke. The members and their friends then grouped themselves outside the north wall of the castle, on a sloping tree-shaded bank, and heard an exhaustive paper by Dr. Hunter, entitled "Memorials of Craignethan Castle and its vicinity." In this interesting communication the author traced the history of the district from the remotest historic period, touching, as he passed along the stream of time, on the

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political and social records of the famous old building under the shadow of whose crumbling walls the party rested. On its conclusion, or at least after as much of it had been read as time and exhausted nature on the reader's part permitted him to do, Mr. Young shortly explained the salient geological features of the locality.

Thereafter the members proceeded from labour to refreshment, and on the soft and springy turf numerous groups were soon busily engaged transferring the contents of hampers and bags to other receptacles which seemed nothing loth to stow away the good things plentifully provided for their especial filling up. Around the more settled parties hovered the unattached, roving like bees from flower to flower, and sipping nectar, or other appropriate beverages, as they passed. All things, even good ones, have their end, so such agreeable exertions had after a time their natural conclusion, and when the call to labour once again was heard a brave and hearty band prepared to follow their leader through straight or devious ways. And, indeed, the latter epithet would but faintly describe the path which was taken along the bank of the Nethan, from a point higher up the stream than the promontory on which the castle stands. A number of the ladies fortunately did not venture, but those who did, and not a few of the sterner sex also, had in numberless places to scramble along the shaley and shelving banks, holding on by hands and knees, or even, as it might fairly be said, by the skin of their teeth.

After a considerable distance was so traversed more civilised paths were reached, and a descent was then made to the rocky bed of the Nethan, where some of the characteristic fossiliferous beds were exposed. Here the wielders of "hammer and chisel and a'" had their innings, and a number of interesting specimens were obtained, including jaws and teeth of fish. From this point the party separated into its individual elements. Some proceeded down the glen of the Nethan till they reached the high and sloping banks of the Clyde itself, whence they could see many of the famous orchards of Clydesdale in their gorgeous beauty of apple-blossom, and the pleasant village of Crossford nestling almost directly below.

Some of the more enthusiastic collectors preferred to linger amongst the strata, and fill their collecting bags with specimens; others botanically inclined gathered the rare plants of which not a few have Craignethan Glen for a safe abiding place; while not a few, where two were company but three were none, preferred their own companionship, enshrined amongst the lovely and fragrant emerald green of the luxuriant foliage. By five P.M. most of the party had again reached the castle quadrangle, where a hearty and unanimous vote of thanks was awarded to Dr. Hunter for all the care and trouble he had taken in conducting the excursion. A move was then made to the station, where the carriages reserved were speedily filled, and at the appointed hour the special train was again *en route* for the smoky town—contrast sufficient to the fairy dells of Craignethan. An hour's ride brought the party to the Central Station, and farewells were said, with the Masonic sentiment felt if not expressed—

Happy to meet, sorry to part,
Happy to meet again.

M.

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## BRAIDWOOD.

### 1st July, 1882.

*Joint Excursion with the Edinburgh Geological Society.*

On Saturday, 1st July, 1882, in pursuance of what has now come to be looked upon as an annual feature of the excursion programme, the members of the two Societies visited Braidwood, in the Carluke district, on the Caledonian Railway system, with the twofold object of seeing some of the more salient geological features of the neighbourhood, and of inspecting the treasures of the well-known collections of Dr. J. R. S. Hunter of Daleville, who had kindly invited the party to meet at his house. A finer day could not have been selected, and accordingly a company of from 30 to 40 members of the Glasgow Society left the Central station at 10.4 A.M. On reaching Braidwood station the party was welcomed by Dr. Hunter, and under his guidance proceeded at once to the head of Braidwood Gill, near Beanshield House, where, before commencing the more arduous work of the day, luncheon was provided, and, shaded by the greenest of foliage from the overpowering rays of old Sol, the members spent a pleasant time waiting the arrival of their Edinburgh friends, who came *via* Carstairs. Here, almost under their feet, in the steep scaurs could be seen fine sections of the lowest horizon in which Carboniferous fossils had been found in the district, and lying immediately over the unfossiliferous strata of the cement-stone series in the calciferous sandstone group.

In this appropriate spot Dr. Hunter read a paper on the geology and archæology of Braidwood, in the course of which he said that he had much pleasure in again meeting his friends of the two Societies on Braidwood ground after a lapse of nearly 18 years. The musketry of grim Death had done much execution amongst the Edinburgh members who had assembled on that memorable day he referred to, and not a few had gone from the Western Society also, but on looking around him he still saw the ranks were well filled up, and that old friends and trusty veterans were neither few nor far between. Long might they be spared to do good scientific work, and to wield the hammer again in Braidwood Glen.

Coal and lime have been worked from very remote periods in the parish of Carluke. A good many years ago, while workmen were making some alterations for the Castlehill Ironworks, they discovered an old pit-shaft about 4½ feet in diameter, of circular form, and which had been used as a spiral stair for taking up the coals. In the old workings baskets of wicker-work, somewhat similar to those of the Newhaven fishwives, and with carrying straps of the same material, were got, but of course all in a rotten condition. A pick was found, the shaft being totally destroyed, about 10 inches from point to point, and formed of four plies of iron imperfectly welded together, on one end still retaining a thin tip of steel which had been clumsily put on. It was a usual practice in olden times to carry coal and other material from the pits in sacks laid across the backs of horses. The earliest notice of coal being worked in the parish is that in an application to the kirk session of Carluke as follows:—"Sess. 25 August, 1650. The q$^{lk}$ day Claud Hamilton of Garein desired liberty to set the water off the coalhaugh upon the Sabbath morning q$^{lk}$ was granted because it was ane wark of necessity." Tradition asserts that the lime used in the construction of Glasgow Cathedral was procured from the Gare limestone of Carluke.

In modern times we find Guy Ross, Carluke; Alexander Russell, Law; Robert Carmichael, Haverstanes, Braidwood; and John Selkirk of Beanshields, opening

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up pits and opencasts for the working of the coals and limestones of the district. Then commenced in earnest the working of the minerals to feed the furnaces of Castlehill, Coltness, and other ironworks in the West of Scotland. At this time all the material was taken from the pits to its various destinations in carts, which, though an advance upon earlier methods, seems very primitive indeed to us who look upon the great iron roads with their leviathan engines and innumerable trains of waggons. Time does make many changes, and possibly the day may come when present arrangements will be looked upon as being as far behind, as we are now in advance of our ancestors.

The first notices regarding the stratigraphical and palæontological details of the district were given by the late Mr. John Craig, mineral surveyor, who published some valuable papers in the pages of the "Practical Mechanics' and Engineers' Magazine," and who evidently had a good knowledge of the minerals of Lanarkshire. He lived, however, before his time, being far in advance of the engineers of the day, and doing good service to the development of the mining industry; while to his advice, without doubt, the success of some of the wealthy ironmasters of the West of Scotland may be attributed. A memoir of this far-seeing and honest man should be drawn up for the *Transactions* of the Geological Society of Glasgow, so that the memory of his geological skill, courage, and determination might be more widely known amongst us than they can at present be said to be.

After Mr. Craig appeared the late Dr. Rankin, of Carluke, who published a sketch of the local geology in the "Journal of the Highland and Agricultural Society." He took great delight in all geological and archæological details connected with the parish, and in the course of his long life did great service in these departments of science. There is no question that his name will go down to posterity as one of the most faithful students that Scottish geology has ever possessed.

Few parishes have such a great vertical range of strata exposed by outcrop as Carluke, but it would be now impossible to go into particulars. Suffice it to say that there are more than 500 fathoms in vertical depth from the upper coal measures at Law to the strata upon which the party were then gathered—*i.e.*, those below the *Productus punctatus* beds at Beanshields. The whole section may be roughly divided as follows:—(1) The lower coal measures, embracing the strata from immediately below the *Productus giganteus* limestone to the calciferous sandstone; (2) the lower Carboniferous or mountain limestone, comprising beds from the *Productus giganteus* limestone to the *Lingula* limestone; (3) the middle coal measures, embracing strata from the gas or cannel coal to those immediately above the Carluke first coal; and (4) the upper Carboniferous limestone, comprising strata from the Howgate limestone to those above the Gare limestone.

In the parish there are numerous dislocations of strata from igneous action. A huge dyke brings the Gare beds at Whiteshaw, Carluke, back to the west, the Kiltongue coal being on the other side, indicating a displacement of upwards of 150 fathoms. Another large fault can be traced from near Lee House, passing Braidwood onwards to Mauldslie Law. It brings down the middle coal measures against the lower Carboniferous limestone series, producing a hitch of about 80 fathoms, the gas coal and *Productus giganteus* limestone being seen nearly on the same horizon at John's Brae, Braidwood Gill. Numerous minor faults or dislocations are observable, both in the coal and limestone series, and cause a vast amount of trouble and expense to the mineral workers.

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Dr. Hunter then entered into details regarding the palæontology of the district, starting from the lowest beds where organic remains were first found by Dr. Selkirk, of Carluke, many years ago, gradually ascending the section, and giving, by means of stratigraphical and palæontological details, a correct idea of the contemporaneity of fossils, and of the frequent changes of condition under which the flora and fauna of the Carboniferous period existed.

Passing then to the archæology, he remarked that it was of a very interesting character indeed, numerous relics of bygone years having been preserved, including stone implements, Roman and British coins, and pieces of armour, besides buildings of ancient date. Braidwood seems to have been a place of considerable importance at an early period, being mentioned by Blind Harry in his "Wallace":—

> Syne couth to Braidwood fayr,
> At a council three days sojournyt there;
> At Forrest Kirk, a meeting ordeened he,
> Thar chesit Wallace Scottis Wardand to be.

The tower or fortalice of Braidwood is of the simplest Norman or old Scottish Baronial type—square—one apartment above another, connected by narrow stairs passing up inside the wall, battlemented, and covered with a stone roof. This mass of masonry is 24 feet 8 inches square, with walls of the average thickness of 5 feet 6 inches, the height to the top of the battlements being 45 feet, and the total height 58 feet. There are five apartments in all. It has been carefully kept in good repair by the proprietor, Sir N. M'Donald Lockhart of Lee.

The party, after hearing Dr. Hunter's interesting sketch, proceeded down the outside edge of Braidwood Gill to a section of strata in the richly fossiliferous beds of the *Lingula* ironstone series, and in which *Lingula squamiformis* is the characteristic fossil. Here masses of the rock had been detached by several of Dr. Hunter's men, and soon hammers and chisels were in full activity, and a considerable number of specimens characteristic of the strata were obtained.

The character of the day had now changed, and deep down in the recesses of the glen the light failed fast. The ominous growl of thunder was heard, and rain-drops began to patter through the leaves, giving warning of the coming storm. Accordingly the route was taken for Daleville, and hardly was its welcome shelter reached than the rain came down in torrents, and vivid lightning-flashes showed that the storm was not far distant. For fifty hungry people to invade a country house is no joke, but Dr. Hunter's establishment seemed prepared to receive all comers, and was more than equal to all demands, so that in no prolonged space of time each guest had to cry, "Hold, enough!" Before and after enjoying the good things set before them the members of the party were busily engaged inspecting the treasures, geological and archæological, with which Daleville is literally crammed, the general feeling being that days, not to speak of hours, would be inadequate to see the "Braidwood" collection.

The sun having again asserted himself, the members of the party rambled about the grounds, which are pleasantly laid out. One curious point of interest was seen in following up a small tramway which ran near the house. This was found to lead up the bank of a small stream, and at the distance of less than 100 yards was found to dive into the hill through an "ingaun ee" or "creepie heugh," the explanation being that Dr. Hunter mines his own coals for household purposes, a most convenient arrangement, and one showing the abundance of Carboniferous wealth in the district.

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Further up the same little glen was descried a small building erected over the stream, and on entering it was found a complete assemblage of lathes, lapidary wheels, and other appliances, all worked by water-power, the "mill" having been recently erected by Dr. Hunter at considerable cost for the sole purpose of cutting and polishing sections of rocks and fossils. The mode of operations was explained by one of the workmen in a practical way, and the details excited great interest amongst all who were privileged to see the completeness of the arrangements.

Time now wearing on apace, a recall was made to the front of the house, and when the party, with the exception of some few who had to leave for an early train, was assembled, Mr. JOHN YOUNG, F.G.S., in the name of the Geological Society of Glasgow, proposed a hearty vote of thanks to Dr. and Mrs. Hunter for the kind hospitality with which they had received the two Societies. This was not the first occasion on which their members had been entertained by Dr. Hunter, and many present would remember former entertainments on their visits to the district during the past twenty years. With regard to the extensive and magnificent geological collection which they had just had the pleasure of examining, although somewhat hurriedly, it had grown up, he might say, from small beginnings, entirely through its owner's care, energy, and skill. The nucleus was the large and fine series of fossils collected by Dr. Hunter and his brother-in-law, Dr. Selkirk of Carluke, from the Braidwood main limestone, during the years when they worked this valuable bed for industrial purposes. It had been enriched from time to time by specimens derived from other localities in the limestone strata around Braidwood and Carluke, as well as from the upper coal measures of the same district, and those of the neighbouring Airdrie coal-field, the fossils from these last deposits being chiefly remains of fishes, amphibians, and plants. Dr. Hunter had also added largely to his collection from the limestone strata of Lanarkshire, by having had presented to him the large and valuable series of specimens from the Brockley coal-field, collected by his friend Mr. Adams, colliery manager, Bankend, the result of the work of many years.

Mr. Young went on to say that Dr. Hunter is now engaged in the formation of a collection of the Silurian fossils which are found in the hills to the south of Lesmahagow, chiefly in the banks of Logan Water and its tributaries, and already made famous to geologists by the researches of Mr. Slimon of Lesmahagow. The remains from these beds are chiefly crustacean, some of them of large size, and belonging to many species and genera. Dr. Hunter has, however, already discovered several species in different horizons of strata from those previously worked by Mr. Slimon, and it is certain that some of them will prove new to the district, and others new to science. Large as this Silurian collection is, it has yet to be added to, and when complete it is Dr. Hunter's intention to have the whole examined and described by a competent palæontologist, so that an exhaustive and descriptive catalogue may be prepared for scientific purposes.

Dr. Hunter has also, as the members had seen, formed a very large and fine mineralogical collection, chiefly from the mines of the Wanlockhead and Leadhill district, and embracing numerous specimens of the crystallised ores of lead, zinc, iron, &c., amongst them being beautiful examples of Leadhillite, Lanarkite, Caledonite, Anglesite, Calamine, Pyromorphite, &c. Dr. Hunter's kindred pursuit of archæology should not be forgotten, and of it they had seen many interesting examples in their cursory examination of the treasures which Daleville contained. In conclusion, Mr. Young said, he was sure he was expressing the

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sincere wish of all present, that Dr. and Mrs. Hunter might be long spared in health and strength to carry on the work of adding to and completing the "Braidwood Collection," and to exercise the same bountiful hospitality which the party had that day experienced in their visit to Daleville.

Dr. BLACK, member of the Edinburgh Geological Society, for himself and his fellow-members, cordially reciprocated the sentiments expressed by Mr. Young.

Dr. HUNTER, in reply, said that it had not only given him much pleasure to see the members of the Glasgow and Edinburgh Geological Societies once more assembled under his roof, but that he hoped those of them who were pursuing scientific investigations, and who wished to collect specimens or obtain further information, would not be backward in calling upon him at any time, for he could assure them always of a hearty welcome at Daleville. For himself and Mrs. Hunter he had to express his sincere thanks for the hearty good wishes which had been expressed by Mr. Young and Dr. Black, and to hope that at no distant date he would again be able to welcome the party at Daleville.

Mr. MURDOCH, secretary of the Geological Society of Glasgow, begged to propose the continued prosperity of the Edinburgh Geological Society. It had now become almost an "institution," as the Americans say, that the two societies should have a common meeting-ground at least once a year, and this was the fifth annual occurrence of such a gathering. On the previous occasions the joint party had visited Midcalder, the Pentland Hills, Bathgate, and Beith, and he hoped that the scenes of future excursions would prove as full of interest as those had been. He thought that such meetings were useful to all who attended them, as ideas were interchanged, and friendships were formed which lasted often for life. In connection with the Edinburgh Geological Society, he begged to couple the name of one of its well-known working members—Mr. John Henderson.

Mr. HENDERSON briefly replied, and in return wished all health and prosperity to the Geological Society of Glasgow.

With three cheers for Dr. and Mrs. Hunter, the party then took its way to the Braidwood Station. The homeward journey to Glasgow passed quickly by with conversation and story, and the Central Station being reached good-byes were said, with the expression of a feeling that the day had been an enjoyable one, and that a future visit to Braidwood and its treasures was an event to be looked forward to.

M.

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## REVENUE.

| RECEIPTS. | | | DISBURSEMENTS. | | |
|---|---|---|---|---|---|
| Balances—Due by Treasurer at close of last Account, | £0 0 8 | | Printing *Transactions*, | £43 2 0 | |
| Due by Librarian at do., | 2 11 11 | | Lithographing for do., | 4 6 0 | |
| | | £2 12 7 | Binding *Transactions* for Library, | 1 11 6 | |
| Subscriptions—Arrears for 1878-79, 5 at 10s., | £2 10 0 | | Books and Magazines added to Library, | 7 17 5 | |
| Do. for previous years, 6 at 10s., | 3 0 0 | | Printing Syllabus, Circulars, Receipt Book, &c., | 15 3 6 | |
| For current year, 173 at 10s., | 86 10 0 | | Rent, Gas, and Insurance, | 11 18 4 | |
| New Members, 16 at 10s., | 8 0 0 | | Collector's Commission, Postages, and Petty Expenses, | 5 10 10 | |
| | | 100 0 0 | Expense of distributing *Transactions*, | 2 2 1 | |
| Publications Sold, | | 6 1 0 | Disbursements by Secretaries, | 14 9 5 | |
| Interest—On Bank Account, | £1 17 10 | | Do. by Librarians, | 1 6 4 | |
| On Loan to Glasgow Corporation, | 3 18 4 | | Travelling Expenses to Prof. Lapworth, F.G.S., | 2 2 0 | |
| | | 5 16 2 | Lodged in Bank, | 130 7 10 | |
| Petty Receipt, | | 0 5 6 | Balances—Due by Treasurer, £1 9 6 | | |
| Drawn from Bank, | | 129 2 7 | Due by Librarian, 2 11 1 | | |
| | | | | 4 0 7 | |
| | | £243 17 10 | | £243 17 10 | |

## STOCK.

| | | | | | |
|---|---|---|---|---|---|
| Current Liabilities, | | £6 7 1 | Cash lent to the Corporation of Glasgow, | | £100 0 0 |
| Balance to Credit, | | 393 16 4 | Cash in British Linen Co. Bank— | | |
| | | | On Deposit Receipt, £109 1 5 | | |
| | | | On Current Account, 12 1 5 | | |
| | | | | 121 2 10 | |
| | | | Cash in hand—Of Treasurer, £1 9 6 | | |
| | | | Of Librarian, 2 11 1 | | |
| | | | | 4 0 7 | |
| | | | Publications, Fossils, and Casts, | 175 0 0 | |
| | | £400 3 5 | | £400 3 5 | |

## LIFE SUBSCRIPTION ACCOUNT.

| | |
|---|---|
| 1879—October 1.—By Balance, | £105 0 0 |



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# Abstract of the Treasurer's Accounts for the Year ending 30th September, 1881.

## REVENUE.

| RECEIPTS. | | | DISBURSEMENTS. | | |
|---|---|---|---|---|---|
| Balances—Due by Treasurer at close of last Account, | £1 9 6 | | Bookcase for Rooms, | | £14 0 0 |
| Due by Librarian at do., | 2 11 1 | | Paper for Printing *Transactions*, | | 5 12 6 |
| | | £4 0 7 | Printing Circular, Receipt Book, &c., | | 2 2 9 |
| Subscriptions—Arrears for 1879-80, 2 at 10s., | £1 0 0 | | Rent, Insurance, and Attendance, | | 13 11 6 |
| For current year, 160 at 10s., | 80 0 0 | | Collector's Commission, Postages, and Petty Expenses, | | 5 3 0 |
| New Members, 17 at 10s., | 8 10 0 | | Carriage of Parcels, | | 0 16 10 |
| | | 89 10 0 | Disbursements by Secretary, | | 5 15 3 |
| Life Membership Subscription, | | 5 5 0 | Do. by Librarian, | | 1 0 3 |
| Interest—On Bank Account, | £2 9 1 | | Lodged in Bank, | | 162 18 7 |
| On Loan to Glasgow Corporation, | 3 18 0 | | Balances—Due by Treasurer, | £1 12 7 | |
| | | 6 7 1 | Due by Librarian, | 1 10 10 | |
| Drawn from Bank, | | 109 1 5 | | | 3 3 5 |
| | | £214 4 1 | | | £214 4 1 |

## STOCK.

| | | | | | |
|---|---|---|---|---|---|
| Current Liabilities, | | £14 19 1 | Cash lent to the Corporation of Glasgow, | | £100 0 0 |
| Balance to Credit, | | 452 4 4 | Cash in British Linen Co.'s Bank— | | |
| | | | On Deposit Receipt, | £128 8 2 | |
| | | | On Current Account, | 46 11 10 | |
| | | | | | 175 0 0 |
| | | | Cash in Treasurer's hands, | £1 12 7 | |
| | | | Do. in Librarian's hands, | 1 10 10 | |
| | | | | | 3 3 5 |
| | | | Furniture—Bookcase, | | 14 0 0 |
| | | | Publications, Fossils, and Casts, | | 175 0 0 |
| | | £467 3 5 | | | £467 3 5 |

## LIFE SUBSCRIPTION ACCOUNT.

| | | | | |
|---|---|---|---|---|
| 1881—September 30.—To Balance, | | £110 5 0 | 1880—October 1.—By Balance, | £105 0 0 |
| | | | 1881—February 22.—By Thomas M. Barr, | 5 5 0 |
| | | £110 5 0 | | £110 5 0 |

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# *OFFICE-BEARERS FOR SESSION* 1882-3.

**President**—SIR WILLIAM THOMSON, LL.D., F.R.S., &c.

**Vice-Presidents.**

| *For Three Years.* | *For Two Years.* | *For One Year.* |
|---|---|---|
| MR. DAVID FORSYTH, A.M. | MR. DUGALD BELL. | MR. ARCHD. ROBERTSON |

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| | | |
|---|---|---|
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| MR. ROBERT MASON. | REV. W. WILLIAMS. | MR. JOHN KIRSOP, F.S.A. Scot. |
| MR. THOMAS NAISMITH. | DR. J. J. DOBBIE, M.A. | MR. JAMES C. CHRISTIE. |
| MR. DANIEL WILSON. | MR. JAMES COUTTS. | MR. JOHN YOUNG, F.G.S. |

**Treasurer**—JOHN WIGHT, C.A., 150 Hope Street.

**Librarian**—JOSEPH SOMMERVILLE, 76 Henderson Street.

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1874. Gray, James, at Mrs. Bow's, 148 Hill Street, Garnethill, Glasgow.

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1883. Millar, Daniel G., M.A., Elgin Terrace, Dowanhill.
1867. Millar, John (J. Black, Drew & Co.), 23 Royal Exchange Square, Glasgow.
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1866. Robertson, John, 10 Valeview Terrace, Mount Florida.
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1866. Taylor, William, 144 Wellington Street, Glasgow.
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[1869]
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# TRANSACTIONS

OF THE

# GEOLOGICAL SOCIETY OF GLASGOW.

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## No. XXIII. — Volcanic Disturbance of the Ironstone Measures in the vicinity of Dalry during the Carboniferous Period. By Robert Craig, Langside, Beith, Corresponding Member.

[Read 7th December, 1882.]

*Introduction.*—The purport of this paper is to show the intermittent character of the volcanic ash which disturbs the mineral field on the south and west of the village of Dalry; and in bringing this subject forward it may add to the interest if I give a passing notice of other volcanic eruptions found in the locality.

The Carboniferous strata of North Ayrshire and Renfrewshire rest upon an extensive group of rocks of volcanic origin, consisting of a series of irregular beds of reddish and greenish ash, porphyrite, felstone, and dolerite. In the parish of Beith they have been bored to the depth of about eighty fathoms without their base being reached. Good sections are to be seen in the hills and in the water-courses outside of the limestone outcrop. Thin bands of carbonaceous matter are found in the series, and in the bores put down two thin layers of impure coal were discovered, from which it may be inferred that some, at least, of the volcanic eruptions have taken place on a land surface. One of these layers of coal, six inches thick, was found about thirty or forty fathoms below the base of the lower limestone, and may therefore be identical with the "Lady Anne coal" of Renfrewshire, which lies thirty fathoms below the lower limestone, and is seen in outcrop in the Gryfe Water above Bridge of Weir. The volcanic ash seen in sections in the parishes of Dalry and Kilbirnie appears to have been



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re-arranged under water; water-worn stones are present, and the beds have the appearance of a coarse sedimentary deposit. This extensive volcanic deposit entirely fills up the place of the calciferous strata, which proves that, while the Burdiehouse limestone and its associated deposits were being quietly laid down on the east of what is now Scotland, a continued series of volcanic eruptions was going on in the west and filling up the place of these strata with volcanic matter.

*Ash-beds in the Lower Limestone.*—A long time of repose seems to have followed this period of volcanic eruption, and the sub-series of limestone beds has been quietly laid down without interruption. A shallowing of the sea has taken place during the deposition of the two upper beds, ending in a land surface, followed by an outburst of volcanic activity. A deposit of clayey ash, running from 18 inches in the Pudduff Burn, Kilbirnie, to 8 feet at Hesselhead, Beith, and divided in some places into two beds by a few inches of carbonaceous shale, has been followed by the land sinking into sea-bottom, and a long period of quietude, during which above 60 feet of limestones and shales have been laid down.

This fine deposit of limestone has been interrupted and brought to a close by another outbreak of volcanic activity, accompanied by an out-throw of ash. At one time I was puzzled with this ash-bed and the fossils found mixed up with it (*Transactions*, vol. vi., p. 9). Fossils of true marine character were found associated with those of estuarine character, and *Ostracoda* representing deep-sea characters were found in association with land plants. In deepening a burn at Old Mill, Beith, the ash and the top of the limestone were cut into and a section exposed, and an inspection of this, with a farther examination of the other sections, explained the difficulty. In this section it was evident that there were two deposits of ash divided by a period of time long enough to have allowed a forest of *Sigillaria* and other plants to have grown up, if not also to decay. The whole is explainable as follows:—The first outbreak of ash was accompanied by the upheaval of the sea-bottom into a land surface. Then followed the forest of *Sigillaria*, the remains of which, in the shape of roots, are found in North Ayrshire, wherever the stratum in which they are imbedded has been preserved. The land then again became submerged, and a thin deposit was formed full of fish remains of estuarine character. This was followed by a second eruption of volcanic ash, forming a

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deposit about two feet in thickness, the lower six inches containing fish remains. In the section first examined considerable erosion of the limestone surface had taken place, and the draining of water by the eroded "cutters" had brought down the upper ash, and also the fossils of the estuarine band, into a mixture with the lower ash-bed, and thus the fossils had become all mixed up together. The first outburst of ash and the uprising of the sea-bottom had caused a great destruction of the fish-life common to the marine limestones, fish teeth being very abundant in the top of the limestone; and the erosion bringing down the others, as I have already stated, makes this one of the richest fish-beds in the locality for the collector.

In the sixty or seventy fathoms of strata which lie between this ash and the blackband ironstone, no volcanic deposits are met with —a thin bed, about 15 fathoms above the lower limestone, seen in Kerrsland Glen, excepted. This has the appearance of an igneous bed, but has too little exposure to be reliably described.

*Ash above the Blackband Ironstone.*—Immediately above the blackband ironstone there is a series of beds, the result of volcanic eruptions of an intermittent character which have continued for a long period. They disturb, and partly usurp, the place of the seventy fathoms of strata that lie between the blackband ironstone and the Highfield limestone; and consist of greenish, reddish, and greyish ash, often indurated into a claystone which disintegrates rapidly on exposure to the atmosphere. A few bands or thin beds of dolerite, hard and durable, are found in the series. The nucleus of these ash-beds is found on the farm of Tower, about one mile south of Dalry, whence, rapidly thinning to the north, they disappear altogether at a distance of three miles. However, ash of identical character and on the same horizon is found in the Lugton Water, above Sevenacres Mill, Kilwinning, and nearly five miles south-east of Tower. Unfortunately for geological science, no correct journal of these beds was kept in sinking the numerous pits that perforate the strata around Dalry, and the geologist is confined to the part exposed in the watercourses. At Tower, Dalry, they have been bored into for 115 fathoms without finding the base; at Langlands, less than a mile to the northwest, their thickness is 99 fathoms; at Braidly, nearly a mile farther to the north, they are but 40 fathoms; while about a mile farther north the whole ash is only two fathoms thick. Across the valley from Tower, and

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on to the east, they thin off even more rapidly. In the Langlands pit shale-bands were interbedded in the ash with sandstones, and at least one band of clay ironstone of two inches, with a band of coal six inches thick. Attached to the ironstone I found *Lingula mytiloides*, Sowerby, and in one inch of clay shale, interbedded in a bed of coarse sandstone one foot thick, the same shell was very abundant. In some of the interbedded sedimentary strata plant remains were abundant.

The following sections are exposed and show the intermittent character of the deposit:—

SECTION IN CAAF WATER, WHERE THE WEST KILBRIDE ROAD CROSSES IT.
(TAKEN UP THE WATER.)

| No. | | ft. | in. | No. | | ft. | in. |
|---|---|---|---|---|---|---|---|
| 1. | Yellow sandstone, | 8 | 0 | 8. | Volcanic ash, | 30 | 0 |
| 2. | Volcanic ash, | 12 | 0 | 9. | Coal, | 0 | 5 |
| 3. | Sandstone, | 3 | 0 | 10. | Shale, | 3 | 0 |
| 4. | Volcanic ash, | 3 | 0 | 11. | Sandstone and shales, | 15 | 10 |
| 5. | Clay shale, | 2 | 0 | 12. | Highfield limestone and shales, | 13 | 3 |
| 6. | Volcanic ash, | 20 | 0 | | | | |
| 7. | Limestone (no fossils), | 2 | 9 | | | | |

SECTION IN BRAIDLY BURN.

| No. | | ft. | in. | No. | | ft. | in. |
|---|---|---|---|---|---|---|---|
| 1. | Impure ironstone, | 0 | 3 | 5. | Sandstone, hard, | 0 | 6 |
| 2. | Volcanic ash, grey, | 1 | 6 | 6. | Volcanic ash, soft, | 0 | 3 |
| 3. | Do., mixed with sand, | 1 | 3 | 7. | Sandstone, hard, | 0 | 6 |
| 4. | Do., green, | 2 | 3 | 8. | Volcanic ash, | 60 | 0 |

Sections of similar import are found in the Rye Water and in other streams, and, although giving a very imperfect view of the whole deposit, being mere sectional fragments, they are yet valuable in showing the intermittent character of the ash-bed. At Tower, Langlands, and in a pit near Linn, where the ash is thickest, the main coal, and a large part of the coal and ironstone measures, are awanting, and their place is filled up with the ash. At Doggartland and Ryeshome, where the ash is reduced to a few fathoms, the main coal and most of the other strata are found. It is evident that here the volcanic matter has been quietly thrown out, probably in the shape of mud, at intervals after periods of rest. During these periods of rest the sedimentary depositions, which make up the coal measures, have been creeping up over the ash, followed by such life as the *Lingula*, to be buried by the next overflow of ash. The ash is found in beds, from a mere film bedded in shale, to masses 60 feet in thickness, and, though this is caused by the tailing out of the ash, it is not always so; thin beds

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of ash half-an-inch in thickness are found at no great distance from Tower, proving that the amount of matter erupted has been as irregular as the length of the times of repose and activity. The limestone, No. 7 in the section on the Caaf Water, is much mixed with ash mud, and this is the case with both the shales and sandstones interbedded in the ash. Had journals of the pit been kept, it would have been interesting to learn the varying thickness of the ash-beds and sedimentary beds in the different pits, as they approached or receded from the ash nucleus.

*Ash above Linn Limestone.*—After the volcanic activity here noted had exhausted itself, a period of repose followed, long enough to have deposited the upper limestone series and the associated strata, amounting to 73 fathoms, or thereabouts. When these strata had been laid down, the old volcano, or one near to it, had again broken out, the remains of the eruption being found in a small section in the Caaf Water above Linn Spout, where the 30 feet of amorphous sandstone is thrown down to the west by a break that crosses the stream. The section, taken in ascending order, is as follows :—

| No. | ft. | in. | No. | ft. | in. |
|---|---|---|---|---|---|
| 1. Shale, mixed with ash, | 4 | 6 | 6. Impure coal, | 0 | 7 |
| 2. Volcanic ash, | 3 | 0 | 7. Shale, | 4 | 0 |
| 3. Impure coal, | 0 | 7 | 8. Volcanic ash, in three beds, | 3 | 7 |
| 4. Sandstone, with land plants, | 0 | 9 | 9. Shale, | 2 | 6 |
| 5. Volcanic ash, | 6 | 6 | | | |

From this it will be seen that, similar to the ash above the black-band ironstone, this outbreak has been also of intermittent character. It is evidently the base of the outbreak of volcanic action which lies below the upper coal measures of the Kilwinning and Irvine districts. Upon this I do not at present enter, farther than to say that while this section, and a considerable part of it not seen here, is in true order of sequence or contemporaneous with the deposition of the strata, a large part of the volcanic rocks below the upper coals are intrusive and belong to a period long subsequent to the deposition of the coal.

In conclusion, had it been in my power to have given one or two pit sections of the ash above the black-band, a clearer view of this outbreak would have been afforded, but I hope that what I have stated will assist you in understanding both the intrusive and intermittent character of the interesting volcanic phenomena of the Dalry district, which has been the sole object of my paper.

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## No. XXIV.—Biographical Sketch of the Late Robert Slimon, Licentiate of the Faculty of Physicians and Surgeons of Glasgow, Corresponding Member. By John R. S. Hunter, LL.D., F.R.Ph.S.E., &c.

[Read 9th November, 1882.]

We have to regret the removal from amongst us of one who held a prominent position in his own district, and largely identified himself with the interests of his adopted parish. I refer to the recent death of Mr. Robert Slimon, of Lesmahagow, who departed this life on the 12th of October last. It is an unusual circumstance for me to appear before you in the character of a biographer, but I know that in this case it will be in harmony with your feelings, as it is with my own, that I should do so. Our departed fellow-worker had claims in the regard of a wider range than his private circle. He was amongst the first of our pioneer geologists, and did good service in elucidating and working out the geology and palæontology of southern Lanarkshire in both Silurian and Carboniferous strata. He was well-known in the geological world for his discoveries among the Silurian rocks, and with these his name will be always identified.

The last time I saw Mr. Slimon was when I called at his house one day about two months ago on the way to my tent "Siluria" on the Logan Water. We had a good deal of information to receive and impart, and he told me that if he was a little stronger he would enjoy going over the ground again with me. This, alas! was fated never to take place, as instead of regaining strength he lost it, and the end soon after came.

Mr. Slimon was interested in a wide range of subjects. He was a well-informed student in various branches, an enthusiast in geology, a devoted astronomer, and an admirable amateur artist. He was by nature of a very retiring disposition, and never used his knowledge for the purpose of display, so that few who had not the opportunity of drawing him out upon some favourite subject would have expected the depth of his information. Those of his friends, however, who knew him best, saw in him the clear-headed thinker, pure-hearted, high-minded, and incapable of an ungenerous thought. His nature made him think and act with least reserve towards those who were fellow-workers in his favourite pursuits, and all such must mourn the loss of a kind and tender-hearted friend.

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Very little information regarding the early life of Mr. Slimon can be obtained. He was born on the 16th October, 1803, at Douglas, in Lanarkshire, and thus at the time of his death had reached his 80th year. His father, John Slimond, labourer in Douglas, was married to Marian Kennedy on 3rd June, 1797, and there were five children born of the marriage, Robert being the third. His father died when Robert was very young, and he began his working life as a hand-loom weaver with a Mr. Bow in his native village, but leaving this trade he took up that of a bookbinder, for which there was surely not much scope in Douglas. He next removed to Cumnock and worked as a snuff-box maker, but after some time migrated to Glasgow, employing in the same business a number of hands. Whether this business was successful or not I am unable to say, but he next obtained a situation in a druggist's shop, and while serving here attended the classes in Stirling's Medical School. He afterwards lived sometime at Crossford, near Lanark, then at Lesmahagow, went back again to Glasgow, and afterwards settled down for life at Lesmahagow, probably practising as a doctor at all these places. In 1864 he received the diploma of the Faculty of Physicians and Surgeons of Glasgow, and in 1867 he was elected a corresponding member of this Society.

For the "Annals of the Parish of Lesmahagow,"* Mr. Slimon wrote a short account of the geology of the neighbourhood, which well displays the minuteness and extent of his knowledge on the subject, and this is, so far as I am aware, his only published paper. I have been informed that he began the study of geology from reading an elementary work on the subject, and that in his field-work he first collected specimens from the Carboniferous rocks at Boghead, Auchenbeg, and other localities in his extensive parish. The famous crustaceans with which his name became afterwards identified were, I have been informed by one of his family, found out accidentally one day when, on his way to visit a patient, he walked up the banks of the Logan Water. His eye happened to catch some strange markings on the rocks beside the stream, his attention became rivetted on them, and for a number of hours while his investigations lasted he entirely forgot that there was such a thing as a patient in existence. This took place in 1851, and I find the story is confirmed by a statement to the same effect in Dr. Henry Woodward's Monograph on "British Fossil

* By Mr. Greenshields of Kerse, 4to, Glasgow, 1864.

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Crustacea,"* which was given from information supplied by Mr. Slimon himself.

This was, however, not the first discovery and collection of organic remains from the Silurian strata exposed in the banks of Logan Water. Many years earlier they had been found and gathered by James Fallow, son of a farmer at South Brackenridge, Lesmahagow, whose farm lay on the Logan Water. I lately saw his mother and she gave me the substance of the following particulars regarding her son. He used to steal away up the water, hammer in hand, to collect the "curious stanes," as he termed the fossils, much to the annoyance of his father, who used to find fault with him and prohibit him from going back to his "absurd" employment. He was, however, far too deeply engrossed by it to resist the attraction, and, as a keen geologist, continued to collect specimens from his favourite Logan Water till a few days before he sailed for New Zealand in 1881. He had been working at these rocks more or less since 1843, but had never, during all that time, come in contact with any geologist, so far as his mother knew, except Mr. Slimon, and therefore his name had never become known to fame as it might otherwise have done. He was certainly a most diligent collector and observer, and a born knight of the hammer. His collection would have been magnificent had he cared about retaining his specimens, but many of the finest were from time to time given to his friends as presents. Not a few have found a resting-place in my own—the "Braidwood"—collection, amongst them being the first specimen he ever got from Logan Water. It was James Fallow, without doubt, who was the real discoverer of the Lanarkshire crustaceans, and it is only right that he should be known as such. He rendered great help to Mr. Slimon in his extended researches amongst the Silurian rocks of the district, Mr. Slimon's own sons also giving their father much assistance in the work.

At the meeting of the British Association held in Glasgow in September, 1855, great interest was excited at the announcement then for the first time publicly made of the discovery of gigantic crustaceans in the Upper Silurian strata of Lesmahagow, and by the exhibition of so many new and rare forms. Mr. Slimon's collection, which had been brought down to Glasgow to illustrate one of his lectures in the winter of 1854-55, was afterwards placed in one of the rooms of the Bath Street Exhibition, where, at the time

* Published by the Palæontographical Society, 1866 to 1878.

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of the meeting, Mr. John Young called Mr. David Page's attention to the more remarkable forms. Mr. Page with difficulty induced Mr. Slimon to exhibit some of his specimens before the Geological Section at the College (then in High Street), and they were then brought under the notice of Sir Roderick Murchison. As soon as that eminent geologist cast his eye on the fossils and the matrix in which they were embedded, it occurred to him that they belonged to the Upper Silurian zone, and with Professor A. C. Ramsay he lost no time in visiting Lesmahagow under the guidance of Mr. Slimon, his chief object being to ascertain the true position of the crustacean-bearing dark schist. He knew that *Pterygotus* (one of these large crustaceans) had been found as low in the Silurian system as the Upper Caradoc beds; but no Upper Silurian strata being yet known in Scotland, he was anxious to identify, if possible, the Lesmahagow beds with those of the highest Silurian zone as developed in Herefordshire, Shropshire, and Westmoreland, and also in Russia and North America. He stated that Mr. Slimon's discovery was of the highest importance, as geologists had begun to despair of finding any representatives of the Ludlow formation in Scotland. In a report on the geology of Lesmahagow, made by Sir Roderick Murchison to the British Association in 1859, Mr. Slimon's observations were embodied and his labours as a geologist were deservedly mentioned with honour.

The late Mr. Salter described and figured the most interesting species of the Lanarkshire crustaceans under the generic names of *Himantopterus* and *Pterygotus* in the *Quarterly Journal* of the Geological Society. He also there gave a drawing of the phyllopod crustacean *Ceratiocaris* with the body and tail spines attached, thus demolishing the theory of the tail spines being fish defences, as was believed at that time by many geologists. From Page's "Advanced Text Book of Geology," second edition, 1859, we find that author to have been in possession of specimens from the Logan Water Silurians much better than those described and figured in "Memoirs of the Geological Survey," monograph I., 1859, by Professor Huxley and Mr. Salter, and I am told that these had been given him by Mr. Slimon, with whom he was very intimate. In Dr. Henry Woodward's monograph of the British Fossil Crustacea previously referred to, the Lanarkshire crustaceans have been well wrought out and described, and many fine specimens procured by Mr. Slimon are to be found in the British Museum and in other collections.

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As I have before remarked, Mr. Slimon was a student of astronomy, and he gave at one time two lectures in the City Hall Saloon, entitled "Astronomical Geology." From a newspaper report now before me, he seems to have advanced in these various rather startling hypotheses. He asserts that the sun is not an attractive body, but a repellant one; and insists that the laws of attraction or gravitation cannot explain or account for the elliptical orbits of the planets. He asks why, if the sun is an attractive body, does the earth move in an ellipse, always in an ellipse, and always in the same ellipse? If the ellipse be caused by the attraction of the outer planets drawing the earth out, why is the ellipse always the same, since the relative positions of the outer planets are never the same? This, he says, is inexplicable according to the law of gravitation, but substitute repulsion for attraction, and the difficulty disappears. When the earth is in its perihelion it presents the southern hemisphere, almost entirely water, to the repeling rays of the sun, which not only penetrate the water, but are absorbed by it, and the earth draws closer to the sun in spite of his repulsive efforts. Gradually, however, as the earth moves in its orbit, the land, the solid matter of the earth, begins to present itself to the sun, whose propelling power, now acting on more resistable matter, gradually pushes the earth out until it arrives at its aphelion, when the northern hemisphere, almost entirely land, is presented to the sun, and the earth is then at its greatest distance. This, in short, is Mr. Slimon's theory of the elliptical orbits of the planets, and whether true or false it is certainly very ingenious. Nor is he the only one who has questioned the validity of the theories of gravitation and solar attraction. The late Professor Nicol, of the University of Glasgow, in a lecture on the comet of that day, said that the law of gravitation furnished so inefficient an explanation of planetary and cometal phenomena that many astronomers were beginning to doubt its truth.

Mr. Slimon next took in hand the comets, and although they may seem to have been created for the express purpose of turning the heads of astronomers, they became, in his hands, perfectly tractable and governable. All planets have been comets originally, and comets are planets in process of growth. At every successive revolution of a comet its perihelion is greater and its aphelion less, showing that its orbit is becoming more circular and more planetary in its character, affording presumptive proof that

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it will ultimately settle down as a quiet member of the solar system.

In his second lecture Mr. Slimon continued and finished his hypothetical exposition of the formation of the earth. He confined his attention almost exclusively to the age and formation of the various primary, or as he termed them "plutonic," rocks. He said that quartz, mica, and felspar were formed before granite, which is merely a mechanical mixture of these three constituents. He asserted that such "plutonic" rocks as show stratified layers were not formed of sedimentary deposits, but were a combination of "silicum" in a plastic state, with gases which existed in the interior of the earth. Quartz he supposes to have formed a "dome" all round the globe, mica a "dome" inside the quartz, and felspar a "dome" inside the mica. The sedimentary rocks, or those resulting from the detrition of the "plutonic" rocks, and from other causes, were formed on the outside, and the more recent "plutonic" rocks on the inside of these "domes." In his theory of creation Mr. Slimon also gave a place to the disputed question of when and how the sea became salt. He supposes these to have taken place during what he terms the "mica" period. Chlorine gas being emitted along with the mica combined with soda to form chloride of sodium or common salt, which when taken up by the water made it brackish!

It has been impossible for me to do more than touch a few of the most prominent points advanced in these curious and interesting lectures, embracing as they do geology, astronomy, chemistry, and natural philosophy, and showing that, whether rightly or wrongly, Mr. Slimon thought vigorously for himself. My attention was drawn to them by his friends, who requested me to give an outline of them to the Society. It is, I believe, their intention that these lectures, accompanied by other as yet unprinted papers, shall shortly be published, so that all who are interested may learn what were the scientific tenets of our worthy and amiable corresponding member.

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## No. XXV.—On the Identity of *Ceramopora* (*Berenicea*) *Megastoma*, M'Coy, with *Fistulipora minor*, M'Coy.* By John Young, F.G.S.

[Read 18th January, 1883.]

Professor M'Coy in his "Synopsis of the Characters of the Carboniferous Fossils of Ireland," 1844, figures and describes, amongst the Zoophytes (p. 195, pl. xxvi., fig. 13), a small incrusting organism as *Berenicea megastoma*, and says, "The general form of this little coral is that of a small, nearly circular, flat scale; the cell-openings are unusually large, and having a raised edge only to the superior half of the margin, their form appears nearly semicircular." In Professor Morris's "Catalogue of British Fossils," 1854, this organism is placed amongst the Bryozoa in the genus *Diastopora*, and as such it is recorded from our strata in nearly all the lists of Scottish Carboniferous fossils. Mr. G. R. Vine, of Sheffield, has, however, recently shown in his paper, "On the family Diastoporidæ," † that M'Coy's *Berenicea megastoma* should more properly be placed with the genus *Ceramopora* of Hall.

The organism, in the form in which it has been described by M'Coy, is not uncommon in many of our Carboniferous limestone shales, but it is also obtained in larger, thin, incrusting patches, which vary in extent from half-an-inch to two inches or more in diameter. In this state it is generally found attached to stems of crinoids, corals, shells, and fronds of polyzoa, and until recently was believed to be the adult or full-grown condition of the organism.

In a paper on Carboniferous Polyzoa, read before the Society in 1879, ‡ I called attention (p. 213) to some new characters which I had found in *Berenicea megastoma*, M'Coy, viz.:—that certain specimens show that the perfect mouth or opening of the cells are of a trilobed form, having two small tooth-like projections on the raised lip of the cells, and, also, that the cells are closed by a thin calcareous cover, and that the spaces between the cells show a minute cellular structure, best seen in slightly worn specimens. These discoveries have since led me to continue my examination

* An Abstract of this Paper appeared in the *Annals and Magazine of Natural History*, December, 1882.

† *Quarterly Journal* of the Geological Society, August, 1880, p. 359.

‡ *Transactions*, vol. vi., part 2, 1882.

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of specimens of this species from all the localities from which I could obtain them, and my researches have quite satisfied me that the organism had continued to grow in many instances beyond the first thin incrusting stage, until it had formed calcareous layers sometimes upwards of half-an-inch in thickness. In the earlier stage I found that the cells were much reclined, but as the organism increased in thickness they were seen to become more erect, and formed tubes, which were tabulated at varying intervals, the smaller cells between these tubes being more closely and regularly tabulated than the larger.

At this stage of the investigation I was struck with the resemblance of *Ceramopora* (*Berenicea*) *megastoma*, M'Coy, to that of *Fistulipora minor*, M'Coy, an organism also found in our limestone strata, but not very abundantly, and which has now been placed amongst tabulate corals of the Monticulipora group. An examination of this organism, as identified from our beds, with that of the older stages of *Ceramopora megastoma*, M'Coy, satisfied me that they were identical in all their points of structure, and on grinding sections of *Fistulipora minor*, M'Coy, near their base, I was further convinced of their identity, by finding the cell-mouths of a trilobed form, and much reclined as in the young incrusting stage of *Ceramopora megastoma*, M'Coy. At this point I was very much assisted in understanding correctly all the external appearances presented by *C. megastoma*, M'Coy, from its early incrusting stage until it became identical with *Fistulipora minor*, M'Coy, by the study of a very interesting paper by Dr. Gustav Lindström, of Sweden, "On the Affinities of the Anthozoa Tabulata."* In this paper (pp. 5, 9) the author calls attention to certain Silurian fossils which have been referred to as corals of the tabulate group, but which, he says, are in reality Bryozoa. As evidence of his assertion, he refers to the common Silurian fossil, *Monticulipora petropolitana*, Pand., which he says begins life "as a Bryozoan, as a *Discoporella*, as what Hall has termed *Ceramopora imbricata*," and he then goes on to describe it briefly from its earliest stages of growth until it arrives at that where it becomes a *Monticulipora*.

The several stages of growth noted by Dr. Lindström in this Silurian form are almost identical with what we find in the Carboniferous one. In the first stage, in our *Ceramopora*, we find it incrusting, the cells being depressed or oblique, and radiating from a

* *Annals and Mag. of Natural History*, 4th series, vol. xviii., 1876.

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bare central spot or macula. In its next stage it is found in larger incrusting patches, the cells being still much reclined, and having their mouths of a trilobed form when perfect, but roundly triangular or pyriform when the outer surface is worn. The more perfect trilobed form of the cell-mouths is due to the occurrence of two short spines which project, one on each side of the raised lower lip of the cell—a character likewise noticed in some of the Silurian *Ceramopora*.

In this stage of growth in *C. megastoma*, M'Coy, we find the first evidence of the thin calcarous covers, formerly noted, which are seen in the cells of the larger tubes. They probably form the successive tabulæ seen in the later growth of the organism. In this stage, also, we find that the outer surface of the cells in well-preserved examples, when examined under the microscope, shows a minute and regular pustulate structure.

The next stage is where we find the organism in thicker incrusting patches, and in which the larger cells are seen to become more erect, while their mouths become nearly circular, the openings in some specimens being quite round, with a slightly raised rim to the cell; but the roundly triangular form of the cell-mouths of the earlier stage can always be traced in such specimens when sections of the organism are cut near the base, the outer surface, when well preserved, also showing the minute pustulate ornamentation noticed in the former stage. In this stage, which Dr. Lindström calls the third, we often find the small polygonal cells or tubes, which occupy the space between the larger tubes, closed by a thin, dense, calcareous outer layer, which leaves only the larger cell-openings visible. This he terms the *Thecostegites* stage; but when such is the case the smaller tubes can always be exposed by grinding a little way below the surface, so as to remove this layer. It is probable that it is this outer layer which forms the successive tabulæ in the smaller polygonal tubes, just as the calcareous covers found in the larger cells may be the tabulæ of these tubes; for I find these external characters in all the stages of growth.

The last or oldest stage in which I have found this organism is in incrusting patches, and in specimens which have at some time become detached from the organisms to which they were once fixed. These vary from one to six or eight lines in thickness, the thicker specimens often showing several concentric or zonal layers of growth, in which the larger cells form erect continuous tubes,

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opening at the surface, with nearly circular mouths. In all specimens which have their structure well preserved, the larger tubes are seen to be tabulated, the tabulæ, which are nearly horizontal, being somewhat irregular in their distance from one another. In some specimens they are less than the diameter of the tube apart, while in others they are much wider, which leads me to think that in some cases they have partly disappeared during fossilization. The smaller polygonal tubes, on the other hand, are always closely and more strongly tabulated, the tabulæ being generally horizontal, but sometimes curved or vesicular. In this, the last stage of the organism (so far as I am acquainted with it), it is identical with *Fistulipora minor*, M'Coy, and I now find that all the specimens which I had formerly identified with *F. minor* from the limestone strata of Western Scotland, when studied under the new light thrown upon them, must be regarded as only the more advanced stage of *Ceramopora megastoma*, M'Coy. This I have been able satisfactorily to determine from the preparation of numerous sections of the organism in all its stages of growth now in my own collection, as well as from the careful study of a large series of specimens in the cabinet of Dr. J. R. S. Hunter, several of which, from the Braidwood limestone of Carluke, are in beautiful preservation, showing the internal structure. In Dr. Hunter's polished sections one is enabled to trace clearly, even in the same specimen, the several phases of the organism, from its first *Ceramopora* stage, in which the cells are seen to be reclined, and with roundly triangular mouths that have thickened, raised lower lips, onwards into the *Fistulipora* stage, where the larger tubes become erect and open at the surface, with nearly circular mouths, and have their interiors partitioned off by tabulæ. I have also well-preserved specimens from the Ayrshire Carboniferous limestones, which show the same stages of structure; and this leads me to remark that, as we have only one species of *Ceramopora* in the Carboniferous strata of Scotland which is also found in all the localities with *Fistulipora minor*, there is therefore no room left for doubt as to the direct identification of the organism in all its stages with that which ultimately becomes *F. minor*, M'Coy.

The genus *Fistulipora* was formed by Professor M'Coy in 1849, five years after his *Berenicea megastoma*, to which species he makes no allusion when describing *Fistulipora*. Two Carboniferous species, *Fistulipora minor* and *F. major*, were described in the

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*Annals and Magazine of Natural History* of that year. In describing *F. minor*, he states that the organism is found "incrusting crinoid stems or other foreign bodies," and that the tubes "are from ½ line to nearly one inch in length, according to the age of the example." In defining the generic characters of *Fistulipora* in the *Annals*, he mentions the existence in the tubes of "transverse funnel-shaped diaphragms at variable distances," but this, however, he seems to have found out was a mistake, as in redescribing the genus in his "Palæozoic Fossils," 1855, he omits any reference to the "funnel-shaped diaphragms"; and in describing *F. minor*, he says, "diaphragms in the main tubes slightly irregular, about half their own diameter apart." Although M'Coy must have seen his *Fistulipora minor* in various stages of growth, it never seems to have occurred to him that it was only an advanced stage of his *Berenicea megastoma*. Probably this arose from his not having seen many examples of the organism in its earliest period of growth. That which he describes as "a spot-like crust" is one of its very youngest stages, and it seems to have been rare in the Carboniferous limestone shales of Ireland, as I only find it recorded by M'Coy from one locality, and not mentioned in his "Palæozoic Fossils" as found in the limestone of Derbyshire, where, he states, his *Fistulipora minor* is not uncommon.

In its young incrusting condition the organism is abundant in certain of the limestone shales in the Lanarkshire coal-field; yet in many localities, except in a few instances, the great majority of specimens have rarely advanced in growth much beyond the first or *Ceramopora* stage. Probably this arose from the conditions being unfavourable to its fuller growth and development over those tracts of the sea-bottom on which much clayey sediment was being deposited. On other horizons, where the strata are more calcareous, as in some of the limestones, it is found in all its stages of growth. On nearly all the specimens which have their surface well preserved, maculæ, and more rarely monticules, are present. These maculæ are small bare spots, about three lines apart, around which the depressed cells radiate outwards and upwards. They are well seen on specimens in the *Ceramopora* stage, and are also seen on specimens in the *Thecostegites* and *Fistulipora* stages, but are not noticed by M'Coy in his descriptions of the organism.

At the present time there exist great differences of opinion amongst palæontologists as to the zoological position of the group

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of organisms forming the Monticuliporidæ. I have already stated that Dr. Lindström places the whole group with the Bryozoa, or Polyzoa as they are more frequently termed in this country. He asserts that he has been able to follow at least one form in all its stages of growth, as I have done in that of *Fistulipora minor*, M'Coy, from its first incrusting *Ceramopora* stage, until it became a *Monticulipora*. Professor H. Alleyne Nicholson, on the other hand, in his "Tabulate Corals" (pp. 285, 288), and in his more recent work "Palæozoic Corals," under *Monticulipora* (p. 60), says, "There are very strong grounds for regarding *Ceramopora* as an independent organism, quite distinct from all the forms of *Monticulipora*." He places *Fistulipora minor* with *Monticulipora*, M'Coy, the former being his type of the genus. He is also, so far as I know, the first British palæontologist who has referred, since M'Coy's descriptions appeared, to some of the characters seen in this organism; but it is evident that Professor Nicholson, at the time he wrote, had never seen specimens of the organism in its earlier *Ceramopora* and *Thecostegites* stages, that to which he refers being the *Fistulipora* or adult stage. In "Tabulate Corals" (p. 292), he says, when writing about the maculæ seen on the surface, that they "never project as stellate elevations above the general surface." I happen, however, to have in my collection one or two specimens which show the maculæ as raised stellate monticules. Professor Nicholson also describes *F. minor*, M'Coy (p. 306), as having "few or no tabulæ in the larger corallites." Professor M'Coy, on the other hand ("Palæozoic Fossils," p. 79), says that they "are only about half their diameter apart." So far as well-preserved specimens in my collection show, I find that the tabulæ in the larger tubes vary in different specimens, being sometimes less than the diameter of the tubes apart, and sometimes much more; but as a rule they are moderately common, and are not to be considered absent or rare.

The foregoing observations on this organism in its several stages have been chiefly derived from the study of specimens in my own cabinet and that of Dr. Hunter, to whom I render thanks. They seem to me to be quite confirmatory of what Dr. Lindström has already shown to be the case with certain of the Silurian *Monticulipora*, but which he refers to the Bryozoa, others to the tabulate corals. I shall not, however, enter upon a discussion of the vexed question as to the zoological position of the organisms showing



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these changes, but shall only state, as regards the Carboniferous form, that one of two things seems certain, viz., if *Fistulipora minor*, M'Coy, be held to be a tabulated coral of the *Monticulipora* group, then *Ceramopora megastoma*, M'Coy, is only its younger stage; if, on the other hand, the latter form be held to be a true polyzoon, then its later stages are only a fuller development of polyzoal life, and *Fistulipora minor* and the other forms indicated in Dr. Lindström's paper in the *Annals* must of necessity be removed from the tabulate corals; but before this can be satisfactorily accomplished a fuller and more extended examination of the Monticuliporidæ will have to be made with those of undoubted genera of Polyzoa.

The following is a list of the localities in Central and Western Scotland from which I have examined specimens of the organism in its several stages:—

LOWER LIMESTONE SERIES.

Craigenglen, Campsie.—*Ceramopora* stage; found in shale; rare.

Corrieburn, Campsie.—*Ceramopora* stage, more advanced; found in shale; rare.

Bathgate, Peter's Hill Quarry.—*Fistulipora* stage; found in limestone; rare.

Dunfermline, Roscobie Quarry.—*Ceramopora* stage; found in shale; moderately rare.

Carluke, Main Lime, Braidwood.—*Ceramopora* and *Fistulipora* stages; found in the limestone; rare.

Douglas coalfield, Brockley, and Bankend.—*Ceramopora* stage, common; *Thecostegites* and *Fistulipora* stages, rare; found in shale.

East Kilbride, Capelrig Quarry.—*Ceramopora* stage, common; *Thecostegites* stage, rare; found in shale.

Hairmyres Quarry.—*Ceramopora* stage; found in shale; common.

Blantyre, Newfield Quarry.—*Ceramopora* stage found in shale; rare.

Hamilton, Boghead Quarry.—*Ceramopora* stage; found in shale; rare.

Howood, Bowfield Quarry.—*Thecostegites* stage; found in shale; rare.

Beith, Trearne, Hillhead, and Dockra Quarries.—*Ceramopora* and *Thecostegites* stages; found in the limestone and shale; rare.

Dalry, Laigh Baidland.—*Ceramopora*, *Thecostegites*, and *Fistulipora* stages found in the limestone; rare.

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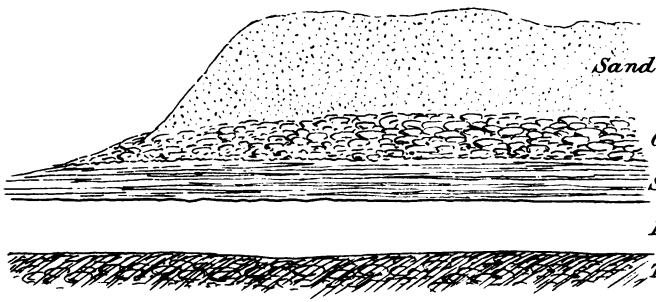
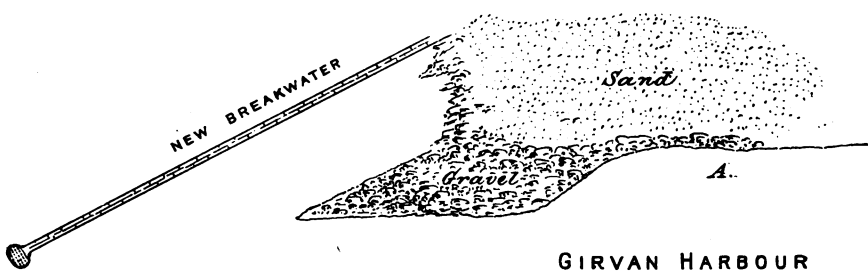
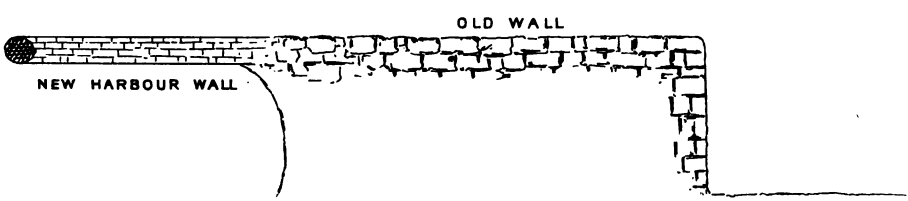



GIRVAN HARBOUR




# PLAN OF GIRVAN HARBOUR.

D. Forsyth del.

Mc Farlane & Erskine, Lith.rs Edin.

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## No. XXVI.—A Bed of Post-glacial Clay, exposed by Dredging in the Harbour of Girvan, Ayrshire. By David Forsyth, A.M., Vice-President. [With a Plate, No. IX.]

[Read 15th February, 1883.]

*General Description of the Girvan District.*—This district lies nearly at the southern angle of the Ayrshire triangle, and is classic from the fossiliferous character of its Silurian strata. There are few districts in Scotland in which, within short distances, the geologist can enjoy such opportunities of studying different strata, and of practically testing so many interesting geological theories. To the south-east and east there is a large Silurian area that constitutes a part of the great tract forming the southern ridge, or axis of elevation across Scotland from S.W. to N.E. To the north-west of the Girvan Valley lies a smaller area of Silurian strata, yet including the famous Mulloch Hill, Drummuck Burn, Threave Glen, and Craighead Quarry. Between these two tracts lies the beautiful valley of the Girvan, which is composed of Carboniferous strata to within a mile or two of the town of Girvan. Three patches of Old Red Sandstone occur in the immediate vicinity—one to the south of the town, one on which the town is built, and one further north, where, near the shore, an old quarry still is occasionally worked. The last two are no doubt continuous, although the union is hidden by the diluvium of the valley.

*Glacial Phenomena.*—The shore to the north of the river is strewn with boulders, many that lay on the south shore having been utilized for housebuilding. In dredging near the shore it is found that a fringe of boulders extends below low water-mark. The majority of these boulders are grey granite, and as no granitic boss is nearer than the head of Loch Doon, ice must have been the agency that carried them to this district. Inland there is not a mountain burn but has some of these strangers blocking its channel. Interspersed among the shore boulders I have found blocks of syenite, granite like that of Arran (at Corrie), smaller pieces of sandstone, coralline limestone, greywacke, and still smaller fragments of such soft rocks as serpentine and graptolitic shales.

*Till.*—Deposits of Till overlie large tracts of the country, the scaurs on the banks of all the tributaries of the Girvan Water showing the depth and frequency of the deposit. The deep scaurs on the banks of the Stinchar are figured by Professor James Geikie

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in his "Great Ice Age," as indicating two periods of glacial deposit. Two years ago, near the Girvan harbour, within 50 yards of the clay which forms the subject of this paper, a well was sunk for the harbour operations, and although excavated to the depth of 43 feet, it did not pierce through the layer of Till. Although the material dug out was closely watched, there were no evidences of intercalated beds, except the sand pockets which occur so commonly in such deposits.

*Post-tertiary Clay.*—This occurs at Dippool or Drumbain, three miles to the north of Girvan, and is made into tiles for the agricultural district around. According to Mr. David Robertson, judging from fossil and physical considerations, there are three distinct layers of clay at Dippool, the lowest marine and the upper more lacustrine or freshwater. I exhibit specimens of the different kinds of clay; but owing to the partial stoppage of the works from heavy rain, I am unable to show specimens of the fossils in the meantime. On the sea-shore, between high and low water marks, there is another stratified clay, a specimen of which I submit also.

*Description of the Girvan Harbour Deposit.*—From the sketch map of the coast-line to the north and south of Girvan, it is evident that the nature of the underlying material is hidden by blown sand; and possibly were this surface covering removed, stratified clays might be found which have escaped denudation. In the recent operations for the clearing and improving of Girvan harbour a deposit of post-glacial clay was exposed, and I carefully watched the material brought up by the dredger or gripper. The position of the clay is best shown by reference to the accompanying sketch of the harbour and the section.

The north side of the harbour has at its greatest elevation a dune of sand, beneath which is a gravel bank. Lower still is a bed of river or estuarine silt, and lowest of all the stratified post-glacial clay. Beyond the accompanying diagrammatic section of the arrangement of the layers of the clay, I can say nothing regarding the depth or extent of the bed. It is not apparent at any other portion of the harbour, and it was only the fact that excavations were being carried on which revealed its presence. Indeed, it was this fact that influenced me to bring the bed under the notice of the Society; for once the harbour works are completed, the post-glacial bed will be no more seen.

*Fossils.*—In all such deposits the evidence of fossils is not con-

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clusive. Although I have taken all these which I exhibit, and of which a list follows, from the solid masses of clay dredged out, yet many recent or doubtful glacial shells also occur. The action of storms, or denudation from river currents, may have scooped out hollows, and so have allowed recent marine forms to be deposited amidst glacial clay; or recent clay-boring animals may have pierced deep down into it from above. Although such deposits cannot therefore be made test-cases of the nature of post-glacial deposits, yet they are interesting as collateral evidence at least of the occurrence of typical forms in adjacent or corresponding areas.

From the colour and physical character of the clay, and its position relatively to the sea-level, I should be inclined to think that the Girvan harbour deposit most resembles the lower bed of the Dippool clay, and that it is like also the smaller bed to the west of that deposit, between high and low water marks.

The colour of this clay is a brownish red, such as one would expect in a clay laid down over a red sandstone area. Then layers of bluish-grey material do occur occasionally; but from the method of extraction I cannot well say how these lie in relation to the red-coloured beds. The clay is composed of exceedingly comminuted particles, although stones are sometimes found. These are usually small, and for the most part are granite, syenite, greenstone, greywacke, and Carboniferous sandstone.

The following is the list of fossils found in the post-glacial clay:—

| | | |
|---|---|---|
| *Fusus antiquus.* | *Tellina balthica.* | |
| *Fusus gracilis.* | *Leda pernula.* | |
| *Buccinum undatum.* | ,, *pygmæa.* | |
| *Natica affinis.* | *Axinus flexuosus.* | |
| ,, *Grœnlandica.* | *Balanus crenatus.* | |
| *Littorina littorea.* | *Unio margaritiferus.* | *Doubtful.* |
| ,, *rudis.* | *Mytilus edulis.* | |
| ,, *obtusata.* | *Cardium edule.* | |
| *Lacuna divaricata.* | *Mactra solida.* | |
| *Velutina undata.* | *Ostrea edulis.* | *Raised Beach.* |
| *Pecten Islandicus.* | *Anomia ephippium.* | |
| *Cyprina Islandica.* | *Patella vulgata.* | |
| *Tellina calcaria.* | | |

I cannot conclude this paper without referring to the kindness of Mr. David Robertson in assisting me to name the shells, and

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as I have been unable to complete my examination of the minute forms, Foraminifera, Entomostraca, etc., I hope to be still more indebted to him in naming these troublesome and difficult forms, and in this way completing the correlation between the beds of Girvan harbour and those of Dippool tile-work.

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## No XXVII.—The Geology of the Isle of Man. By John Horne, F.R.S.E., F.G.S., H.M. Geological Survey of Scotland.

[Read 15th February, 1883.]

The geological formations represented in the Isle of Man are not numerous, but some of them embrace features of special interest. If we except the extensive plain between Ramsay and the Point of Ayre, which is covered with glacial deposits, and the small areas of Old Red Sandstone and Carboniferous rocks in the neighbourhood of Peel and Castletown, nearly the whole of the remainder of the island is occupied with Lower Silurian strata. Consisting for the most part of black and grey slates, grey flags, and occasional bands of sandstone and conglomeratic grit, they bear a close resemblance to the Skiddaw slate series of Cumberland. This correlation is strengthened by the occurrence in the Manx slates of *Palæochorda major*—a fossil which is characteristic of the Skiddaw series. This is the only trace of organic remains which has been hitherto met with in the Silurian rocks of the Isle. So far as the available evidence goes, therefore, the remarkable development of clay-slates in Mona may be regarded as of Llandeilo age. Their prevalent strike is north-east and south-west, which coincides with the trend of the chain of heights forming the backbone of the island. Indeed, there can be little doubt that the existence of this ridge, whose summits vary in height from 1,500 feet to 2,000 feet, must be ascribed to this cause. Few satisfactory sections are to be found inland, but along the coast-line, both on the east and west sides of the island, they are well displayed. The attempts which have been made to discover in the Isle the various subdivisions of the Skiddaw slates established in Cumbria have not been hitherto successful; but several prominent flexures of the strata have been traced. An anticlinal axis extends from Port Moar, near

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Maughold Head, south-westward to the junction of the Glass and the Dhoo rivers, west of Douglas. It is probable that the anticline at Port Erin on the west coast may be the continuation of that at Port Moar, but the evidence throughout the intervening ground is concealed by the covering of drift. The whole of the elevated ground on the island lies to the west of this arch, and the prevalent dip of the strata along the ridge is towards the north-west. Again, to the east of this axial fold there is a well marked syncline, extending from Clay Head, near Laxey, southwards by Douglas to St. Ann's Head. At these headlands the flagstones are associated with bands of grit, some of which resemble the pebbly grit in the Skiddaw series. Possibly these grits may be merely the repetitions of the bands which crop out in Carn Gerjoil on the west side of the anticline.

The Silurian rocks are pierced by certain masses of granite of the ordinary type. One of these bosses occurs near the Dhoon, north of Laxey, and another near South Barrule Hill, in the south part of the island. Within the belt of altered strata surrounding these igneous masses, the metalliferous veins mainly occur. The celebrated veins of ore near Laxey, and the Foxdale mines near South Barrule, which have proved such a fertile source of revenue to this island, have yielded silver, copper, lead, zinc, and barytes.

The strata next in order have been generally regarded as of Upper Old Red Sandstone age. They are analogous to the conglomerates and red sandstones which in Scotland form the lower subdivision of the Calciferous Sandstone series. They rest unconformably on the Silurian rocks, and they pass conformably underneath the Carboniferous limestone of the Castletown basin. The evidence regarding these points is very satisfactory, and perhaps the most convincing section is that which extends from the Langness promontory to the centre of Castletown Bay. At Dreswick Point and at the natural arches the brecciated conglomerates may be seen resting on the upturned and eroded edges of the slates. The common ingredients in the breccias are white quartz and quartzite, though at the base they are commingled with subangular fragments of the underlying rocks. On the beach near Langness farmhouse the perfectly conformable passage between the breccias and the Carboniferous limestone is visible at low tide. Similarly these beds may be traced round the northern margin of the basin, forming a narrow fringe underlying the limestones. At Rushen

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Abbey they have a grey calcareous matrix, in which are embedded white quartz pebbles, and from the beds at this locality the Rev. J. G. Cumming obtained fossils characteristic of the lower limestones, especially *Orthis Sharpei.** To the north of Peel, strata of the same age extend along the coast for a distance of two miles, but differ considerably in character from their representatives at Castletown. The brecciated type has well nigh disappeared, and along the cliffs we have an exposure of red sandstones, which have been largely used for building purposes. With these are associated bands of cornstone, which have yielded specimens of *Favosites polymorpha.*† In this outlier the overlying limestones are not exposed on the coast, but it is probable that they occur not far out to sea, as blocks of limestone are met with on the beach containing fossils similar to those in the Castletown limestones.

In the neighbourhood of Castletown the Carboniferous rocks form a small basin, the long axis of which runs NNE. and SSW. from Poolvash bay to Ballasalla. The following order of succession has been established by the researches of the Rev. J. G. Cumming:—(1) The lower or Castletown limestones, (2) the upper white limestones of Poolvash and Balladoole, (3) the black marble beds in Poolvash bay which are associated with tuffs, indicating a local outburst of volcanic activity during their deposition. That the strata belonging to these various subdivisions differ not only in lithological characters, but also in organic contents, has been amply proved by Cumming's investigations. Upwards of 220 species of fossils were collected by him, from a careful analysis of which it is evident that the lowest division must be paralleled with the main (scaur) limestone, while the middle division is but the counterpart of the upper (scaur) limestone or Yoredale rocks of the North of England. Cumming was of opinion that the black marble beds "had no exact equivalent in the British Isles." Still it is probable, as we shall point out presently, that they also belong to the horizon of the Yoredale series. According to the same authority about 50 per cent. of the 76 species met with in the lowest limestone series are restricted to that horizon, about 76 per cent. of the 153 species found in the white limestones are peculiar to them, while out of the 39 species occurring in the black marble

* *Vide* Cumming's "Isle of Man" (1848), p. 44, from which work the nomenclature here used is taken.

† Do., p. 240.

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beds, 50 per cent. are confined to these deposits.* From these facts it is apparent that these subdivisions are clearly separable from each other. The members of the lowest division are admirably exposed in Castletown Bay, being inclined to the WNW. at angles varying from 6° to 8°. They are traceable northwards along the shore from Derbyhaven to the mouth of the Santon burn, where they have a similar inclination. In the northern portion of the basin they are best seen in the quarries near Ballasalla, with a SSW. and SW. dip, while on the west side from Grenea Point eastwards to Strandhall they are inclined a few degrees to the north of east. At all these localities the strata consist of a succession of dark blue limestones, with thin partings of shales, yielding the following characteristic fossils, *Productus hemisphæricus*, *Orthis Sharpei*, *Natica elliptica*, *Bellerophon cornu-arietis*, and *Favosites cœtetes*. The lower limestones which are exposed on the shore between Grenea Point and the bay at Strandhall with an easterly dip, are truncated by a north and south fault, which is well seen on the beach at Poyll Richie. The effect of this dislocation is to throw out the highest beds of the lower limestones and to bring in the white limestones of the middle division. On the east side of the fault, the limestones are nearly vertical and much shattered, but not far to the east, in the bay to the west of Balladoole House, the white limestones are inclined to the south-east. At Gaw Gortagh near Poolvash they are interstratified with dark calcareous flags and shales, which are evidently the lowest beds of the black marble series. The characteristic fossils of this subdivision are, *Productus striatus*, *Terebratula excavata*, *Orthis resupinata* and *Goniatites crenistria*.

The succeeding series of strata is widely different in character from the two lower divisions, consisting mainly of black shales and calcareous flagstones, varying in thickness from 6 to 18 inches. A remarkable feature of these beds is the association of true Carboniferous limestone forms with abundant remains of terrestrial plants. Upwards of twenty-two species have been obtained which are characteristic of the Carboniferous limestone, while two species, *Posidonia Becheri*, Phill., and *Posidonia literalis*, Phill., are typical of the Yoredale rocks. All these are commingled with such land plants as *Calamites*, *Lepidostrobus ornatus*, *Pecopteris*, *Sphenopteris*. That there is a gradual passage from the white limestones into the black

* *Vide* Cumming's "Isle of Man" (1848), p. 355, *et seq*.

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marble series is evident from the manner in which they alternate with each other in Poolvash bay. The nature of the fauna in the white limestone, as Cumming suggested, implies deposition in a shallower sea-bottom than was the case with the lower limestones, while on the other hand the rich assemblage of plant remains in the highest subdivision points to the close proximity of land. It is probable, therefore, that the latter may indicate a gradual approach to estuarine conditions, and may in reality belong to the close of the white limestone series. This supposition is strengthened by the occurrence of the two species of *Posidonia* already referred to in the black calcareous flagstones. Indeed so characteristic are these fossils of this subdivision that Cumming applied the name Posidonia schist to the black marble of Poolvash. It is of importance to fix the age of these beds with some degree of certainty on account of the volcanic rocks which are associated with them.

By far the most interesting feature connected with the Carboniferous deposits of the Isle is the evidence of volcanic activity during the deposition of the black marble beds. The records of this volcanic outburst acquire additional importance from the fact that they are of rare occurrence in the Carboniferous rocks of England. From the nature of the ejectamenta as well as from the limited area which they now cover, it is evident that the display of volcanic energy must have been comparatively feeble. The orifice from which the materials were discharged is still preserved to us at the Scarlet Point, and the shore sections are so satisfactory that there is no difficulty in making out the history of this ancient volcano. The phenomena displayed at the Scarlet Point forcibly remind one of those characteristic features of volcanic "necks" which are common amongst the Carboniferous rocks of Scotland. Along the cliff from Scarlet Point by Cromwell's walk, the lower limestones are pierced by a coarse agglomerate containing blocks of diabase and fossiliferous limestone from one to four feet in diameter. The truncated edges of the beds of limestone are bent downwards towards the agglomerate, and close by the junction line they are considerably altered and broken. There can be little doubt that this line marks the northern boundary of the vent. The agglomerate is pierced by a wall-like mass of green diabase terminating seawards in the Stack of Scarlet. This mass is about fifteen yards in breadth, and along the sides, as well as on the top of the dyke, the vertical arrangement of the polygonal columns is well seen. Towards

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the centre of the dyke the diabase is compact, but at the edges it is highly vesicular, showing numerous elongated cavities. It can be traced for a distance of 100 yards or so in a NNW. direction, to a point where an isolated patch of diabase-porphyrite rests on the volcanic breccia. Not far to the west of these stacks another small mass of diabase is seen piercing the breccia. As we recede from the old centre of eruption and follow the coast line towards Poolvash, the coarse agglomerate gradually merges into fine green tuff, which on the whole is well bedded and inclined to the west at gentle angles. Where the sea has formed stacks of this material excellent sections are to be seen upwards of 30 feet in depth. At Close-ny-chollagh Point and in the adjoining fields there are small patches of vesicular diabase resting on the fine ash, clearly showing that there must have been a discharge of lava subsequent to the tuff. The farthest limit reached by the tuff on the shore is opposite the farmhouse of Poolvash, about a mile and a half from Scarlet Point. Towards the outer limits of the area covered by the volcanic materials, especially between the Poolvash marble quarry and Close-ny-chollagh Point, there are several sections showing a regular alternation of the black marble beds with the ash. It is evident therefore that this eruption must have been submarine, the earliest phase of which was characterized by the discharge of fine tuffs and volcanic breccia, simultaneously with the deposition of the black calcareous mud. Eventually the coarse agglomerate which filled the vent was pierced by a mass of basic lava which flowed for a short distance from the centre of eruption.

In the south side of the island there is a well marked series of basalt dykes which traverse the Silurian and Carboniferous rocks alike. They have an east and west course and are seen to advantage at Langness, in Castletown bay, and along the shore between Scarlet Point and Poolvash. Cumming associated these dykes with the volcanic phenomena just described, but it is not improbable that they may belong to the great series of basalt dykes of Tertiary age which are so well developed in Scotland and the north of England.

The glacial phenomena present various features of interest to the geologist. Indeed some of them are so remarkable that they can only be adequately explained by taking into account the results of the detailed examination of the glacial deposits in the South of Scotland, the North of England, and the North of Ireland.

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Though the rounded contour of the hills and the iceworn aspect of the cliff-tops bespeak glacial abrasion, still striæ are not abundant. The clay slates are not well adapted for their preservation. They are best seen in the basin of Carboniferous rocks in the south of the island, as for example, at the Scarlet limekilns, in the Poolvash marble quarry, and on the limestone at Port St. Mary, where the trend varies from WSW. to SW. and SSW. At Port Groudale, north of Douglas Bay, on the east coast, the direction is nearly north and south. It is obvious that these ice-markings could not have been produced by any local radiation of the ice, as the ridge of high ground runs in a north-east and south-west direction. In all likelihood they were produced by land-ice at the time when the Irish Sea was filled with the ice radiating from the South of Scotland, the Lake district, and the West of Ireland. This supposition is confirmed by an examination of the Boulder-clay sections throughout the island as well as by the distribution of the boulders. As a rule this deposit is well represented in the bays, and it steals up into the high ground in the form of gently sloping terraces. In the tough stony clay the prevalent striated blocks are of local origin, but with these are associated small boulders of Criffel granite, quartz-felsite, diabase-porphyrite, Permian sandstone, clayband ironstone, chalk and chalk flints. In some instances, two Boulder-clays are met with, separated by a thick succession of stratified sands and gravels, as on the cliff about half a mile south of Ramsey. The old Boulder-clay containing these various foreign rocks is devoid of stratification; in fact it is identical in character with the Till of the mainland, and we have no reason to doubt that it had a similar origin. No less remarkable are some of the facts connected with the distribution of erratics, as Cumming long ago pointed out. Boulders of granite, derived from the mass in the south of the island near the Foxdale mines, have been carried in a south-westerly direction up the slope of South Barrule hill (1585 feet) and across that hill to the top of Cronk-na-Irey-Lhaa (1449 feet). They diminish in number and size as we recede from the centre of dispersion, the largest being found on the slopes of South Barrule. In their course these boulders have been carried to a height of about 800 feet above their parent source. Taking all these various lines of evidence into consideration, the abnormal trend of the ice-markings, the presence of foreign rocks in the Till, and the distribution of some of the erratics, they seem to point to

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the conclusion that the island must have been overflowed by land-ice during the primary glaciation.

In the north of the isle there is a remarkable development of glacial deposits, evidently of marine origin. The great plain which sweeps from Ramsey to the Point of Ayre and south-westwards to Kirkmichael is covered with these deposits, and along the cliffs admirable sections are exposed. These beds have been described by Strickland, and numerous references are made to them by Edward Forbes in his great paper on "The Fauna and Flora of the British Isles." * In a few words he depicts the general succession as presented along that part of the coast:—"In the Isle of Man, the marl-beds containing bivalves of the second or third region in depth are capped by a great thickness of sands and gravels, occasionally containing littoral shells, but rolled. On these sands the larger boulders usually lie." These finely-laminated shelly clays, containing occasional striated blocks of foreign origin, closely resemble the shelly brick-clays of the Firths of Forth and Clyde, and the glacial shells embedded in them agree on the whole with those found in the Scotch glacial clays. This being the case, it is not improbable that they may belong to the same period of depression. After this submergence a considerable elevation of the land ensued, when the Isle of Man was joined to Ireland and England, and the shores of England were united to the continent. Forbes long ago showed that, during this elevation, the Germanic fauna and flora migrated to western regions. The gigantic Irish Elk (*Cervus megaceros*), whose remains are now dug out of the marl pits in Mona, roamed far to the west across this plain. But eventually there followed another minor depression of the land when the Isle of Man was finally separated from the adjacent countries. The submerged forest at Strandhall, in the south of the Isle, with trunks of oak, ash, and fir standing erect in sandy marl, is striking evidence of this depression, while the raised beaches which line the bays, and the wave-washed caves in the cliffs from twelve to twenty feet above the present sea level, as clearly evince the final elevation which the island has undergone.

* See "Memoirs of the Geological Survey," vol. i., pp. 358, 393.

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## No. XXVIII.—Notes on a Recent Flood in the Desert of Atacama, North Chile. By Thomas King.

[Read 8th March, 1883.]

In a paper entitled "Description of a Dry River Bed in North Chile," which I read before the Society on 1st Feb. 1877,* I advanced the theory that the Carrizal valley had been hollowed out by occasional floods occurring at long intervals. I was then able to mention only two floods, but a third has since occurred, and for an account of it I am indebted to my brother, who was an eye-witness of its effects.

On the 13th of July, 1880, there passed over northern Chile a storm of wind and rain such as the oldest inhabitant had never seen. A little to the east of Yerba Buena—the terminus of the Carrizal and Cerro Blanco line—the rain fell in torrents and formed a river in each of the three small valleys that converge just above the station. Old Dan, one of the workmen, saw a head of water rushing down towards him and climbed up the windmill, but he could not see the water itself very well as it carried such a fine top of brushwood. Down it came, filling the large valley with a river of muddy water, and the stones it bore along rattled and rumbled so loudly that the people about the station could hardly hear one another speak. It carried away 300 tons of coal, besides bricks and barley, and nearly took away the station too. Still sweeping on it just wiped out nine miles of the line. About three miles below Yerba Buena the valley gets wider and the grade less. Here the water began to drop the larger stones, and further down the gravel. It followed the course of the line to Algarrobal, 29 miles from Yerba Buena, and then escaped northwards in the direction of Totoral—where there is another dry river-bed, but so far as known little or none of it reached the sea.

From the direction the water at last took, it is evident that the railway does not follow the course of one continuous valley. Beginning at the sea, the first 20 miles of the line lie in one valley, which has smaller valleys opening into it. Then it crosses a plain, 15 miles wide, next enters the valley which was flooded, and ends at Yerba Buena, 60 miles from the sea. In the paper already mentioned, I did not, when treating of the action of "spates," point out with sufficient clearness that I had chiefly in

* *Transactions*, vol. vi., part 1, p. 18.

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view the channel cut through the raised beach. The inland valleys amongst the granitic mountains have a different history, and have been formed or modified by the ordinary denuding agents acting through a very long time, when the surrounding conditions were probably very different. Indeed the north of Chile must at one time have resembled the present extreme south of the country —a number of rocky islands separated by narrow seas. But since the north attained its present elevation the action of occasional floods has gone on modifying the whole land-surface. This action is somewhat complex. We have seen that in the flood of 1880 great quantities of stones and gravel were brought down into the Yerba Buena valley, but were soon dropped, and that even the water hardly reached the sea. It is evident that the action here was not one of hollowing out, but on the contrary one of filling up. I remember that the last few hundred yards of the line lay along an embankment some 6 or 10 feet above the general surface. The flood levelled up the bottom of the valley to the height of the embankment, instead of levelling the embankment down. That a silting up has gone on is well seen in the sinking of wells. I remember looking into a dry well in a valley about 9 miles above Carrizal, which was sunk in gravel. Another was dug in the plain through sand and gravel to a depth of 250 feet. Very probably these silts have not all the same significance, while some are undoubtedly due to the action of running water; others may be marine, dating from the time when the present surface stood below the sea level. What I have just now said regarding the silting up of valleys does not contradict what I formerly said regarding their erosion. The result of both operations may be expressed in the following general statement, namely, that the present condition of these northern valleys as regards depth, etc., has been brought about by the action of occasional floods. These floods are local, and their special action depends very much on where they occur. If that of 1880 had happened near the coast it would have scooped out channels for itself and have borne its spoils to the ocean; but occurring as it did far inland it just dropped them, thus permanently raising the bed over which it flowed.

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## No. XXIX.—Notes on Ure's "Millepore," *Tabulipora Urii*, J. Young (*Cellepora Urii*, Flem.). By John Young, F.G.S.

[Read 3rd May, 1883.]*

The Rev. David Ure in his "History of Rutherglen and East Kilbride," 1793, figures and describes a Carboniferous organism, pp. 328-29, pl. xx., figs 1, 2, as a "Millepore," and says—"The Millepore is a very beautiful genus of the coralloides. It abounds in most of the lime quarries, not only in Kilbride, but in the West of Scotland. The specimens are in fragments, and commonly branched. They are from the thickness of a fine hair to that of a large quill. Some specimens continue to adhere to shells, &c., on which they were originally formed, as in fig. 1. The pores are round and of different diameters in the same specimen, fig. 2, which is greatly magnified. The extremities of the branches were originally round as at *a*. The Millepore is frequently spread on the surfaces of shells, entrochi, &c., like the *Seratula pumila*."

Those who, like myself, have collected Carboniferous fossils from the Kilbride district, and compared them with Ure's figures and the above description, now know that under the term "Millepore" he has confounded various smaller organisms found in the same strata, which bear a certain amount of external resemblance to one another, but are really distinct, both in form, size, and the character of the cells, and which are now grouped under different genera and species from those of the organism to which he specially refers. These are now known as *Ceriopora interporosa*, Phill., *C. similis*, Phill., *Rhabdomeson gracile*, Phill., *R. rhombiferum*, Phill., *Hyphasmopora Buskii*, Ether., jun., and *Archæopora nexilis*, De Kon. These are all at present provisionally placed among the Polyzoa, but the organism figured and described by Ure is now regarded, although somewhat doubtfully, as belonging to the tabulate corals.

In 1828, the Rev. Dr. Fleming in his "Natural History of British Animals," p. 533, names Ure's "Millepore" *Cellepora Urii*, and describes it in these few words, "branched, round, about a quarter of an inch in diameter, form round," (Ure, pl. xx., fig. 1). In Morris's "Catalogue of British Fossils," 1844, the organism appears under Fleming's name, in the list of Polyzoa, but, so far

* An abstract of this paper is printed in the *Annals and Magazine of Nat. History*, September, 1883.

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as I am aware, it has not been further noticed or described by any palæontologist since Fleming's time.*

In 1836, the late Professor Phillips figured and described a somewhat similar organism from the Carboniferous limestone of Yorkshire, under the name of *Calamopora tumida*, which in its habit of growth, and external cell-characters, so closely resembles Ure's "Millepore"—but to which species Phillips makes no reference in his description—that Scottish collectors, ignorant alike of Ure's earlier description, and Fleming's specific name, have gone on identifying this organism with Phillips's species, wholly from external resemblances, the result being that, in recent lists of Scottish Carboniferous fossils, Phillips's specific name of *tumida* has supplanted Fleming's name of *Urii*.

In the short paper which I have to submit to the Society, I hope to point out a new character that I have recently discovered in Ure's "Millepore," which I believe will distinguish it from the organism described by Phillips, and which will, at the same time, enable us to restore to it Fleming's specific name, which I hold has priority over that of Phillips, even supposing the organism is found to be the same. I may here mention, that the organism described by Phillips as *Calamopora tumida*, has during recent years, been placed in no less than three other genera, viz., *Chætetes*, *Stenopora*, and *Heterotrypa*, the last being a new sub-genus established by Professor H. Alleyne Nicholson in 1879 for certain tabulate corals belonging to the Monticulipora group. Ure's "Millepore" will likewise be found in Scottish catalogues under the names of *Chætetes* and *Stenopora*, the latter name being that under which it appears in the Catalogue of Western Scottish Fossils, but with Phillips's specific name of *tumida* attached, but which name I believe should never have been given to the Scottish organism, as it is quite distinct from the form described by Phillips. This I now know from what I have discovered regarding its internal structure in specimens from Kilbride and various other localities in our limestone strata.

My attention was first drawn to Ure's "Millepore" by finding in a beautifully preserved incrusting specimen that the larger cell-tubes were closed by a thin, calcareous cover, which was pierced in

* I find that R. Etheridge, jun., F.G.S., in a paper entitled "Observations on *Chætetes tumidus*, Phill.," *Annals and Magazine of Nat. Hist.*, 1874, vol. xiii. (4th series), refers to *Cellepora Urii*, Flem., as probably belonging to Phillips's species.



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its centre by a small pore or opening of a roundly crescentic or reniform shape. This character in this organism is new to me, and it does not appear to have been noticed by either Ure or Fleming in their descriptions, which were chiefly confined to external characters. Having satisfied myself that it existed in other well-preserved incrusting specimens, it occurred to me this last autumn, that if these calcareous covers were of the nature of tabulæ, they ought to be found preserved within the internal structure of the organism, which in other specimens had grown up into a branching form from the first incrusting stage. I therefore made sections of several specimens both across the branches and lengthwise, and was pleased to find these perforated covers, or tabulæ, as I shall now term them, existing in nearly every specimen which had its internal structure at all well-preserved.

Before, however, describing this internal structure more minutely, I shall first refer to the habit of growth, and other external characters by which this organism is distinguished, and in a fuller manner than has been done by either Ure or Fleming. In its first, or youngest stage, as stated by Ure, it seems to have often formed a thin incrusting layer of cells, which are chiefly found in patches attached to stems of crinoids, corals, shells, and other organisms, and after thus attaining a fixed base of varying diameter it grew upwards in a branching manner until it reached a height of three or more inches. The branches are dichotomous, and terminate, as Ure states, in rounded extremities. In the larger and more robust specimens the branches seldom attain more than $\frac{1}{4}$ inch in diameter, the average being from 2 to 3 lines, and when found uncrushed their cross sections vary from round to oval. In the thin incrusting stage, where the organism sometimes covers a space of two or more inches in length, maculæ, and, more rarely, monticules, are present over its surface. These occur at intervals of from 2 to 3 lines apart. The maculæ consist of spots on which are often seen a few very small cells or pores, surrounded with a group of polygonal cells about one diameter larger than the intermediate polygonal cells which fill in the spaces between one macula and another. The maculæ are also seen on some of the branching specimens, but on these they are often less clearly defined. These maculæ, which are here noticed for the first time, so far as I am aware, in connection with this organism, if held to be of any zoological value, would seem to indicate that its place is amongst the group of tabulate

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corals belonging to the Monticuliporidæ, but this group is now held by Dr. Gustav Lindström and others to be more closely related to the polyzoa than it is to the true tabulate corals. This point, however, I shall leave over for future discussion, and proceed to notice the form of the cells, and the surface ornamentation of the organism, as seen in its several stages.

In young and thin incrusting specimens, the openings of the cells are seen to be more or less polygonal in form, but as the bounding walls between the cells thicken in their growth the openings afterwards often become somewhat round or oval, this being the condition they present in older specimens. If these thickened walls between the cells are carefully examined in specimens which have their outer surface well-preserved they will be found to contain a number of small pores or tubes generally planted at each angle of the cell, while the rest of the wall bears numerous small spinose tubercles in one or more irregular rows, giving the surface of the organism a minutely granulated kind of ornamentation. When the surface of a branch is ground down lengthways a very little way at right angles to the cell openings these tubercles appear in the walls as minute pores, but both they and the larger pores at the angles of the cells gradually disappear in the sections as the specimens are ground nearer to the central axis of the organism from which the cells spring, and they there become polygonal in form, and thin walled, as in the earlier stage. I may here mention that I have found no evidence of tabulæ in the small wall-pores, like those said to exist in the wall-pores of others of the Monticuliporoid group. I shall now proceed to describe the tabulæ I have discovered in the larger cells, which, as formerly stated, I first found evidence of in the younger, or first incrusting stage of the organism, and afterwards in older specimens, by grinding sections of branches.

Before describing the appearance of these perforated tabulæ, I shall first briefly refer to the methods by which I have prepared sections for examination. These consists of cross sections, and longitudinal sections of branches either ground down to transparencies, or polished so as to be examined as opaque specimens. Cross sections for grinding are easily cut from the ends of branches with a thin-edged file, and both they and longitudinal sections are first ground to smoothness on a fine sandstone to the point of structure wanted, and afterwards polished on plate-glass with the

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finest emery powder. If the sections are wanted as transparencies, the polished face is fixed to a glass slide with Canada balsam, which when dried to the proper hardness is then ground on the fine sandstone, and polished on the plate-glass until it is of the proper thinness. In my recent investigation of this organism, I find that, as far back as the year 1871, I had ground to transparency several beautifully-preserved specimens, showing the perforated tabulæ, but from want of knowledge as to their nature at that time, I failed to understand the peculiar structure which these sections now reveal. I find that opaque sections of branches ground down lengthways so as to show the mouths of the tubes at right angles to the surface are best suited for showing the perforated tabulæ in the greatest numbers, in the various cells. Owing to the curvature of the branches these tabulæ do not all lie at the same external level within the tubes when ground in sections, hence, when a specimen of the organism comes to be reduced to a thin transparency, only those few which happen to be at the surface, and lying close to the glass of the slide, remain. In opaque sections, on the other hand, we not only see the tabulæ at the surface of the specimen, but we also see those lying deeper within the tubes shining up through the transparent calcite with which many of the tubes are filled. When sections are cut so as to show the whole length of the tubes from the central axis outwards, the tabulæ are seen to be comparatively numerous, being on the average less than the diameter of the tubes apart, and as many as from seven to ten may be seen in each tube in the space of $\frac{1}{10}$ inch in length or thereby. The perforations or openings in the centre of the tabulæ are, as before stated, of a roundly crescentic or reniform shape, the inner edges being in most instances slightly thickened so as to form a kind of raised rim. I find also, in branching specimens, that the concave edges of the aperture are, as a rule, invariably turned to the lower end of the branches, excepting at these points where bifurcation of the stem takes place. Where this is the case they are seen to be there slightly deflected to either side, and from this character alone one is always able to tell which are the lower or older cells in any fragment of a branch, yet this interesting fact could not easily be ascertained from an examination of any of the external characters seen on the specimen. In examples where the tubes are cut right through the centre of the perforations, in either vertical or cross-sections of branches, the tabulæ are seen as a series of small tooth-like processes, projecting,

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one on each side, horizontally inwards from the walls of the tubes, and often showing a little rounded knob at their extremities, this latter character being due to the thickened rim, formerly mentioned, which exists round the perforation. When the section, however, happens, as is often the case, from the flexure of the tubes, to cut the tabulæ on either side of the openings, they are then seen to cross the tubes in a complete manner, and such a section might mislead as to the regular perforated character of the tabulæ existing in other specimens where they are well-preserved, and in which they happen to be cut in the proper line.

Having fully satisfied myself by the examination of numerous sections of Ure's "Millepore," from all the localities in which I could obtain examples, as to the constant presence of the perforated tabulæ by which it is characterized, I then endeavoured to find out in what other characters it either differed from or agreed with its nearest allied forms. In this investigation I have been very much assisted by the information I have obtained from Prof. Alleyne Nicholson's "Palæozoic Tabulate Corals," 1879. I have, therefore, in the first instance compared the organism with his subgenus *Heterotrypa*, in which he now places *Calamopora tumida*, Phill., and with which, as formerly stated, Ure's "Millepore" has all along been confounded owing to its great external resemblance. At p. 297 Prof. Nicholson states that *Heterotrypa* has two sets of tubes or corallites, both "traversed by complete horizontal tabulæ, which are greatly more numerous in the small tubes than in the larger ones." This is quite a different internal structure from that found in Ure's "Millepore," which, as before stated, has no tabulæ in its smaller tubes, but has numerous perforated or incomplete tabulæ in the larger ones. It, however, agrees in some of its external characters with *Heterotrypa*, in possessing on its surface maculæ in which, in many of the specimens, the cell-openings are distinctly larger in these spots, and also in having the outer cell-walls thickened, and in bearing numerous small spiniform tubercles. I next compared it with the description of *Stenopora*, as now defined by Prof. Nicholson in the same work, pp. 168-177, and which he places amongst the Favositidæ. Ure's "Millepore" agrees so far with *Stenopora* in having a branching habit of growth, cell-walls, externally ornamented with granulated or tuberculated bounding ridges, and in the arrangement of its tubes within the branches, they being, as seen in the

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*Stenopora* (p. 168), "composed of tubular corallites, which are nearly vertical in the centre of the branches, and radiate outwards from an imaginary axis to open on all points of the surface," and also in having the "corallites in the centre of the branches polygonal, thin-walled, and more or less completely in contact." Here, however, its resemblance to *Stenopora* in a measure ceases, for there is no evidence of mural pores in the walls of the tubes, nor is there that evidence of the regular annular thickening of the walls in their outer portion, which is illustrated in "Tabulate Corals," pp. 173-4, figs. 25, 26, in *Stenopora*, as in pl. ix., fig. 1. The walls in Ure's "Millepore," in their outer portion, are very variable in form and thickness, being sometimes straight, sometimes flexuous, and sometimes slightly annulated, but never in that regular form seen in the above figures of Prof. Nicholson's species of *Stenopora*, and this variation in the form of the walls is often very observable in the same specimen. In transparent sections this is seen to be due to the irregular manner in which the sclerenchyma deposit, as Prof. Nicholson terms it, has been secreted on the walls of the tubes. The tabulæ in *Stenopora* have likewise been described as being remote, and complete, not perforated, nor numerous, as in Ure's organism.

I do not at present know of any other genera beyond the two here mentioned with which to compare Ure's "Millepore." I have, therefore, endeavoured, so far, to show that, while it has certain resemblances in some of its characters and points of structure to *Heterotrypa* and *Stenopora*, it differs in other points so widely from them, especially in the possession of perforated tabulæ, that neither of the above genera, as at present defined, can admit it without the introduction of an important character not at present known to exist in either. I have not yet, however, been able to obtain specimens of *Heterotrypa tumida*, Phill., so as to compare for myself its structure with that of Ure's "Millepore," and so far as my examination has gone, it does not appear to exist in any of the Carboniferous limestones of Western Scotland. I am, therefore, unable at present to say how far Phillips's description of his species, and that afterwards given by M'Coy, are to be relied upon, as they both seemingly describe characters not given in Professor Nicholson's *Heterotrypa*, which leads me to think that in their descriptions they have confounded together characters belonging to, or found in different organisms. Thus Professor Phillips in

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his description, "Geology of Yorkshire," p. 200, states that its prismatic cells are "contracted to a smaller opening at the surface," and again that "transverse tubuli (mural pores) appear to stand at the angles" or in the walls of the cells (as shown in fig. 53). Phillips (figs. 56, 57) also shows the external contraction of the cells into a small pore or opening, and says—"It appears that this variety depends on the covering of the surface." Professor M'Coy, in re-describing Phillips's species as *Stenopora tumida*, "Palæozoic Fossils," pp. 82, 83, states that the outer portion of the tubes are "irregularly moniliform," and having each cell-mouth nearly closed by a concave diaphragm, perforated by a small, circular, central opening, about $\frac{1}{3}$ the diameter of the tube." As formerly stated, no reference to any of these characters is made by Professor Nicholson in defining his genus *Heterotrypa*, but some of them resemble what is stated to be found in *Stenopora*, and others those seen in Ure's "Millepore," which leads me to think that both Phillips and M'Coy may have drawn up their descriptions from distinct organisms, externally alike, but differing in internal structure. To show that this may have been the case, I have only to quote Professor Nicholson, who, in remarking upon some of the difficulties that at present attend upon a complete or satisfactory definition of the genus *Stenopora*, and of its separation from the Monticuliporidæ and Chœtetidæ, to which groups it bears such an amount of external relationship, says, "Tabulate Corals," p. 176—"I am unable to say how far a mere examination of the surface with a lens would enable an observer to separate a specimen of the first from one belonging properly to either of the latter genera," meaning *Chœtetes* and *Monticulipora*, in the latter of which Phillips's species is placed. Internally, however, the above organisms are found to differ when examined in sections.

Believing that Ure's Millepore is quite distinct from Phillips's *Stenopora tumida*, and that it possesses characters which, so far as I know, do not seem to have been noticed in that of the genus *Stenopora*, I propose to place the organism amongst the Monticuliporidæ under a provisional new sub-genus, which I name *Tabulipora*, as descriptive of its beautiful and interesting internal structure, which distinguishes this organism from all its near allies. At the same time I add to it the specific name of *Urii*, after the Rev. David Ure, whom I believe to be its original discoverer and describer, and the earliest pioneer of Scottish palæontology.

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In placing it amongst the Monticuliporidæ, I do so in the knowledge of the fact, that it possesses many of the external and internal characters given to this group; though, as to the zoological position of the group in the animal kingdom, there is at present much difference of opinion, one party placing it with the tabulate corals, the other amongst the polyzoa. It is, however, to be hoped that the true systematic position of the group will yet be discovered.

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## No. XXX.—Three Months' Tent Life amongst the Silurian Hills of Logan Water, Lesmahagow. By John R. S. Hunter, D.Sc., LL.D., F.R.Ph.S.E., Honorary Member.

[Read 8th March, 1883.]

In a former paper which I read at a meeting of the Society in 1881,* "On the Silurian Rocks of Logan Water," I sketched the geology of the district, and called special attention to the group of Silurian rocks which has yielded the crustacean remains that have made it famous amongst palæontologists all over the world. I stated then, after remarking upon the fossil forms which I had obtained, that at a later date I hoped to be able, through further research, not only to record other facts, but to present the results of my work in a more extended and better developed form. After carrying out this wish, I now propose to give you a short sketch of my tent life amongst the Logan Water rocks, with some of the results of my labours during the three months I spent there.

My object in taking to extended out-door life in such a high moorland locality was simply in pursuance of the old determination to work out the whole of this district exhaustively. The necessary permission to occupy the ground having been received, I purchased an emigrant's tent, with the needful cooking utensils, including a large Rippingale's patent paraffin cooking-stove, and I may say in passing that this last-mentioned item answered its purpose admirably, and never gave us any trouble during our lengthened sojourn in the land of the Peesweep and the Whaup. Before starting from home I took the precaution to erect the tent, and go through cooking drill, and I may say that we were able, almost at once, to turn out a very satisfactory dinner.

* *Transactions*, vol vii., part 1, page 56.

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Accompanied by my two assistants, after getting all our traps packed in and on the waggonette, I took leave of Daleville one Monday morning in May, 1882. For some time our progress was slow, the road being very steep, and the baggage being heavy and bulky. Jogging on our way we passed numerous parties, who seemed to think us rather strange-looking characters, wondering, doubtless, to what branch of the show business we belonged. Making as much progress as possible, we passed through Hazlebank, Kirkmuir Hill, and Boghead, then up the road at Deadwater Bridge, where the Kype Water passes, on past Breakenridge and Auchrobert, to Dunside, all in the parish of Lesmahagow, which was as far as our vehicle could proceed. Halting here we were welcomed by Mr. Blackwood, farmer, and had tea with him. Carrying the whole of our goods and chattels over Lochfennoch Burn, we requisitioned his light pony cart, and so got them conveyed over the hard moss as far as was practicable, when we had again to unload and carry everything to the proposed site of our encampment, "Shanks Castle," a spot situated close to the banks of Logan Water. No trace of any building has been detected, but as tradition hands down that this was a great resort of robbers and outlaws during the troublous times, now happily passed away, the existence of a ruined building of some sort is at least probable.

We soon erected the tent and hoisted the flag "Siluria," and then carried up the whole of our baggage, not a moment too soon, as the rain came on with a will, as it often does in such elevated situations, reminding one of the lines of the old song—

"There's many a sunny dawning,
And many a morning bright,
That's followed by clouds at noontide,
And ends in a stormy night."

The Logan Water was easily crossed when we arrived, but soon rose to a considerable stream; only those who have seen such waters in rainy times can understand the rapidity with which they rise and fall. The rain did not cease till the following afternoon, which gave us ample time for repeating—

"Come mate, put an end to your groaning,
And banish your sorrow away,
For there's many a rainy morning
Turns out a bright, sunshiny day."

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After the weather cleared we crossed the stream and began work at a likely spot, where we soon found traces of ancient organic life.

It was not, however, till we got down a considerable depth that we came upon specimens worth attention, the excavation that we made involving many days' hard work. We likewise did a great deal of work on the Waterhead farm, finding numerous specimens, also on the Kip Water, and in other places. A good deal of time was spent in trying to find a new horizon for the balls or nodules containing the phyllopod crustaceans, and in this we were ultimately successful; but whether the beds which hold them are higher or lower than those in which I first discovered them, I cannot determine, owing to an intervening dislocation. Here were also found a few small scales, something like those of Acanthodean fishes, and one or two fragments of plant remains—the only indications of vegetable life I have found in the Silurian rocks of Lesmahagow.

Further up the Logan Water than where we made our first excavations numerous shells of Upper Silurian types were got in very fine preservation, amongst them being examples of *Modiolopsis lævis*, Sowerby; *Modiolopsis complanata*, Sowerby; *Goniophora cymbæformis*, Sowerby; *Orthonota impressa*, Sowerby; and *Pterinea Sowerbyi*, M'Coy; besides many which I have not ventured to name. The summer of 1882 was, unfortunately for us, a very wet one, and we were consequently often hindered from working, though patience and perseverance, during fair weather, helped to make up for the loss of time. We were very comfortable in our tent, and at night after supper amused ourselves by singing songs, telling stories, or making speeches in turn, my head man, Willie Smith, often giving songs of his own composition. We had occasional visitors; sometimes one or more of the neighbouring shepherds dropped in, and on several occasions Mrs. Hunter came up with the waggonette, to carry off our accumulated spoils.

Our day's work was generally something like the following:—Rising at six a.m., we had breakfast, and taking some good things with us to keep away hunger till midday, we started for the scene of our labours. Here we toiled till noon, when, if we were near the tent, we adjourned to get some hot dinner, but if not, managed to subsist on cold meat and bread brought with us. We often remained in our digging till late in the day, generally working the

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hardest when we were unsuccessful. When any extra fine or rare specimen was turned up we made the welkin ring with our shouts, so that passers-by, of whom there were seldom if ever any, might have taken us for lunatics escaped from Gartnavel. Only those who have experienced the toils and pleasures of geological campaigning can fully appreciate the intense rapture felt at successful finds, and during the day many a look used to be taken at the stoney beauties as they lay on the turf around us. When we returned home for supper, all the day's incidents were gone over, and a more thorough examination of our specimens was made, but the heart-thrills at our success were never just the same as at the moment of discovery.

Such was our routine life in searching for the "blessed beasties," as one of the party designated the crustacean remains. Our spirits were always kept up by the expectation of still better things to come, and by the feeling that we were sure to find objects worthy of the severe work we had undertaken. No one need dream of going fossil-collecting on the banks of the Logan Water in the same manner as would be done amongst the Carboniferous rocks. It requires hard, hard work, and as a dear old Glasgow geological friend wrote me, it requires "great daring" to catch the crustaceans! What would any of you think as to the propriety of providing yourselves on a geological expedition with the undernoted list of tools, or "graith," as the mining phrase is, taken with us for our explorations:—

| | |
|---|---|
| Steel chisels, various sizes, | 32 |
| Anchor picks, | 2 |
| Miners' picks, | 6 |
| Steel wedges, | 3 |
| Hammers, various sizes, | 9 |
| Small saw, | 1 |
| Axe, | 1 |
| Blasting jumpers, | a set. |
| Shovels, | 3 |
| Pinches (crowbars), | 3 |
| Flask of gunpowder. | |
| Fuses or "strums." | |

In our work of excavation we were much aided by the judicious use of gunpowder, which did us a vast amount of service in detaching huge blocks of the rock, and also in breaking them to

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pieces, though sometimes we had to mourn the loss of fine specimens blown away or broken into splinters.

We had numerous falls of rock coming down on us, which caused us to lose part of our working tools for days at a time, and some, indeed, altogether, but we fortunately suffered no personal damage beyond cut or bruised fingers.

Our tent "Siluria" was furnished by no means luxuriously, though we were extremely comfortable. First there was laid on the ground a large piece of damp-proof material, and above it common tarpauling on which were placed our beds. These consisted of canvas bags stuffed with bog-hay, while we had plenty of blankets and more bags, all of which we needed to keep ourselves warm when the nights were cold or rainy. Our table was of fir-wood, and constructed on the spot, our seats portable stools, while for table-covers we used regularly either the *Herald* or *N.B. Daily Mail.* A shelf held all our crockery ware, and odds and ends, and a large paraffin oil lamp gave us both light and comfort. The tent itself answered its purpose admirably, and I hope and trust that the flag of "Siluria" will in times to come often fly in various districts of Scotland, and not be the solitary one in the land either, for I doubt not that some enthusiastic geologists will ere long follow our example, and experience the joys and pleasures of an extended camping out on or near the scene of their investigations.

I shall now draw your attention to some of the more interesting organisms which we discovered, and the horizons where we found them. At Shanks Castle we found a few slabs containing magnificent specimens of crustaceans—some of which I exhibit to-night—on one slab there being no less than 17 examples of *Ceratiocaris*, and some very large *Pterygotus* were also found there. Some of these beds were in a very crushed and broken-up condition, many species and even genera being huddled up together, as if they had been suddenly overwhelmed and deprived of life, their bodies being contracted, contorted, and curved, the telsons being often bent round towards the heads. Sometimes we hear of what may be a similar phenomenon occurring in recent times in various parts of the world. In one case, off the American coast, and extending over a space of nearly 200 miles, the surface of the sea was covered with the bodies of dead fish. The water was of a brick-red colour, and contained quantities of minute algæ and infusoria. Whether this

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great destruction was caused by the agency of submarine volcanic forces, and the escape of noxious gases, as has been suggested, it is impossible to decide. Some similar causes of death and destruction must have existed in Silurian times. *Ceratiocaris* was found in various horizons on Logan Water, but the finest specimens were got at Shanks Castle, being larger than those from other localities, and showing the contour and structure of the organism to perfection. These phyllopod crustaceans are usually lying in a dark-blue anthracitic shale cut through by quartz veins, so that the slabs are much divided, and care has to be taken when a perfect specimen is found that the matrix does not part at the joints. *Ceratiocaris* is a curious shrimp-like animal closely allied to *Apus* and *Nebalia*. No feet have been detected, but it possesses very large eyes, and is provided with jaws of singular form, while the carapace is beautifully striated. The lobes on some species are finely sculptured, having a thin shelly covering, and the tail spines are varied in form and marking. They were first detected and described by Prof. M'Coy, who named them *Leptocheles*.

In a dark-grey shale near the same horizon, and splitting into large slabs, we found the largest and best specimens of *Pterygotus* ever got in Silurian strata—one specimen being four feet long, and another nearly three, while some heads and telsons of imperfect examples would indicate still larger dimensions. *Pterygotus* is a remarkable and anomalous creature, the head alone appearing to possess the separate organs of feeling, locomotion, prehension, and mastication. Here also were secured some fine specimens of *Eurypterus*, showing beautifully sculptured plates. Of both these groups I have specimens of nearly all the organs separately displayed, and so well preserved that all their characters can be seen in the plainest manner.

At Dunside we quarried extensively, and found some fine things, their structure being very perfectly preserved. Sometimes, however, we worked to little purpose, as fossil remains are not always co-extensive with the strata. Their absence from particular beds, or portions of beds, may be accounted for in various ways. In Silurian times, as at present, the slightest physical changes would affect the existing life—the strength of a current, its deviation, the depth of water, its saltness or freshness, the nature of the sea or lake bottom, the tidal action, the season of the year, amongst others. All such causes influence the migration, breeding and dispersion of

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all inhabitants of shallow water, and hence it is that one particular bed or patch of rock may be swarming with the remains of one or more organisms, while hardly removed from the same place no vestige of former life may be apparent.

Few places in Lanarkshire could exert a more powerful influence on the imagination than the neighbourhood of our sojourn on Logan Water. Its loneliness and remoteness from so-called civilization made us feel the bracing air of freedom in every breeze. The situation of our tent at Shanks Castle was pleasant in the extreme. We were surrounded by grassy hillocks, and a small wood gave us abundance of shelter from the prevailing winds. Here the naturalist and botanist might find occupation in studying many varieties of animal and plant life less common in the lowlands. Meadows and swamps not only harboured many species of water-loving plants, but afforded food and shelter for many kinds of birds which haunt such solitudes, especially in the breeding season. Various ferns were found clinging to the rocks in sheltered spots, and nowhere did the wild flowers appear to bloom in richer profusion. The grassy slopes were soft as the richest Turkey carpet, while the vividness of their bright green contrasted admirably with the deep clear blue of the heavens above. We knew that usually there was not a human being within miles of us, save perhaps a single shepherd, yet we could not call it solitude.

"'Tis but to hold
Converse with Nature's charms, and view her stores unrolled."

Our time had now come to an end, so, not without regret at leaving the free upland life we had grown to like so well, our tent was struck, our baggage conveyed across the moorland, and we entered once more the busy haunts of men, hoping that our sojourn amongst the Logan Water hills would not be the last occasion of our enjoying Tent Life under the flag "Siluria."

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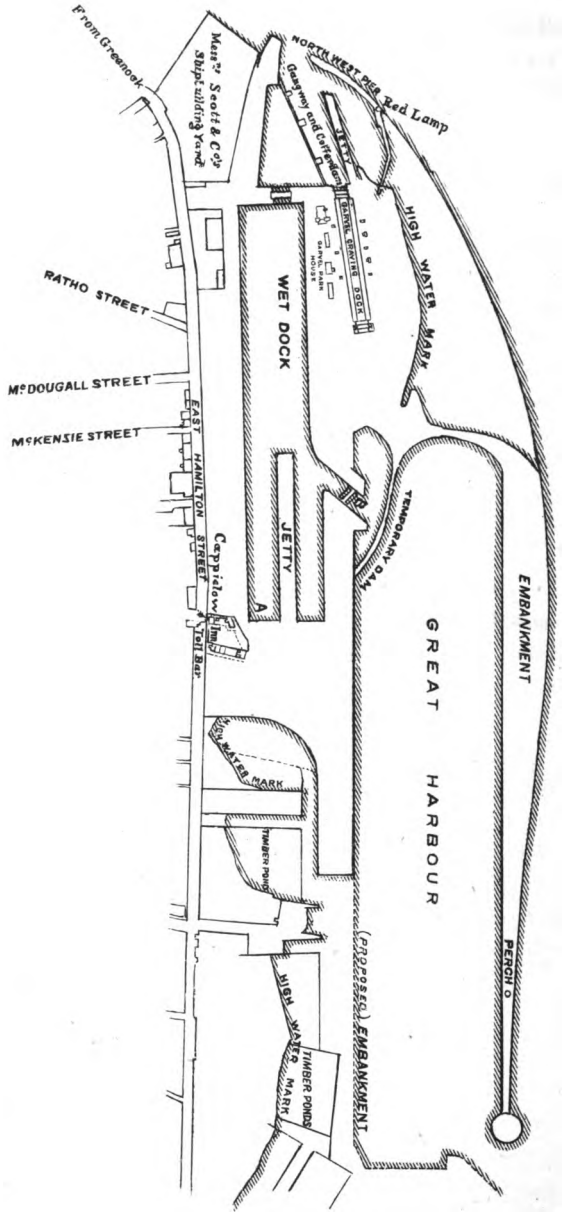


PLAN OF GARVEL PARK DOCKS, GREENOCK.

McFarlane & Erskine, Lith.rs Edin.r

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## No. XXXI.—Notes on the Occurrence of *Leda Arctica* (Gray); *Lyonsia Arenosa* (Möller), and other Organic Remains, in the Post-pliocene Clays of Garvel Park, Greenock. By Thomas Scott and James Steel. [With a Plan, Plate X.]

[Read April 12th, 1883.]

During the extensive excavations made in the course of forming the James Watt Wet-Dock at Garvel Park, Greenock, fine sections of Post-pliocene clays have been exposed. These clays and their contents have been already very fully described, and we should not have cared to add anything to what has been so well said by Mr. David Robertson, had we not, during an extended examination of part of the same deposits, secured a number of organic remains, which Dr. J. Gwyn Jeffreys, to whom we submitted some of them, says "are peculiarly arctic, and therefore more interesting than the usual shells of the Clyde beds." As they decidedly differ from those previously described from Garvel Park, the following notes may not be without some interest.

We visited Garvel Park about the middle of July last (1882)—not having been there for some time previously—and noticed a deep section of clay exposed in the south-east branch of the dock (marked A on plan). This clay we found had been deposited in an abrupt and deep depression of the sandstone rock, which, reaching the surface a little to the west and north, dipped rapidly south-eastwards, till a depth of fully 40 feet was reached. This depth continued but a short distance, when an almost perpendicular face of rock rising nearly to the surface was met with, appearing to indicate a rather extensive fault. The clay which filled this hollow seemed to be made up of three or rather four separate beds. Immediately above the sandstone rock was the usual non- or almost non-fossiliferous laminated clay. Next was what we have taken the liberty to call the "Pecten and Cyprina bed,' consisting of tough hard clay of a dark-reddish colour, and containing boulders of various sizes, and which was in many places so crowded with *Pecten Islandicus* and *Cyprina Islandica* that they formed a distinct and well defined layer, while in other places these shells were more scattered through the bed. These two beds would be together from two to three feet thick, the thickness varying somewhat. Next was a mass of clay, generally

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with more sand in its composition than the other clays, some of it being rather tough, and almost black from the great quantity of organic matter (chiefly vegetable), mixed up with it, some of it very firm and of a dark-reddish colour, containing in places the elliptic variety of *Astarte sulcata* in great abundance, while in others it was nearly pure sand. Above all was from twelve to eighteen inches of a sandy deposit, evidently belonging to more recent times.

In the clay extending from the "Pecten and Cyprina bed" up to the recent deposit were found the various organisms to which we wish to draw your attention; but before doing this it may be as well to explain that a short time after examining the section at the south-east cutting we visited the north-east branch (marked B on plan), where also we found a section of clay which, though not so deep as the other, was yet very similar in composition, and contained the same fossils. As we found that the remains here were on the whole more plentiful and in finer condition than in the other portion, we afterwards confined our attention to it.

As already stated, in the extensive deposit overlying the "Pecten and Cyprina bed" we found a number of shells belonging to a decidedly arctic type, as indicated by the following species:—

1. *Leda arctica* (Gray)—Syn. *Nucula arctica, Portlandica arctica.* Distribution—circumpolar in the North Atlantic and Pacific, Novaya Zembla, Jenissei Bay, Iceland and Finmark, 5·1333 fathoms. Common all through the clay-bed here referred to.

2. *Astarte borealis* (Chemn.). Common all through the bed. Many specimens of larger size and in fine condition.

3. *Lyonsia arenosa* (Möll.). Found in the more sandy parts of the deposit, but not very common. Distribution—Greenland, and Davis' Straits. We cannot find any former records of its occurrence as a fossil in Britain.

4. *Nucula tenuis*, var. *inflata* (Morch.). Common, and in fine preservation. Distribution—Greenland and Davis' Straits.

5. *Modiolaria lævigata* (Gray). Its abundance in some places was remarkable. It was so plentiful that the clay could not be dug without crushing some. Parts of the clay where they occurred were black from the quantity of organic matter mixed through it, and the shells were so easily crushed that it was difficult to get whole specimens. Distribution—Greenland, Davis' Straits, Novaya Zembla.

6. *Dacrydium vitreum* (Torell). This pretty little bivalve was not very common, though frequent in one or two places.

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7. *Thracia truncata* (Brown). Not common, especially full grown specimens, the young and half grown being more frequent.

8. *Buccinum Grœnlandicum* (Chemn.). Not common.

Besides those shells above mentioned we found a number of others and also some ostracoda and foraminifera, some of which we had not before found in Garvel Park. These and some other things from the same deposit are included in the list at the end of this paper.

We noticed that *Pecten Islandicus*, though plentiful in the clay below, was here rare and fragmentary, and the same may be said of *Cyprina Islandica*, except that a whole valve was sometimes found, but *Tellina calcaria* was frequent and of a heavier build than we used to find it elsewhere.

It will be noticed, then, that here we meet with a group of marine fauna decidedly different from, and of a more arctic type than has been found previously in Garvel Park, and that it is confined to a comparatively limited area. The presence of such shells, and especially of *Leda arctica*, would seem, on the authority of Sir Charles Lyell,* to indicate the recurrence of a period of greater cold than that existing during the deposition of the usual shell-bearing clays of the Clyde valley.

We are not satisfied, however, that such is the case with regard to this deposit, for we have noticed no apparent break in these shell clays; the beds appear to be continuous, though the fauna differs. From a frequent examination during the last six or eight months of the section in the northeast branch, we have been able to a great extent to make out that the beds here, though varying a little in the material of which they are composed, and in their relative thickness, are a continuance of the same beds found further west. Knowing that a difference in the material, as well as in the depth of the sea-bottom, is sufficient to account for a difference in the kind of organisms living upon it, we are inclined in the meantime to think that the presence here of the remains referred to, though differing so much as a group from those formerly noticed, may be ascribed to changes such as we have indicated, rather than to the recurrence of a period of more extreme cold. But, possibly, as the excavation of the dock proceeds, the reasons for this difference in the organic remains may be more clearly traced.

* Students' Elements of Geology, 3rd ed., pp. 156–187.



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In concluding this paper we wish to acknowledge our obligations to Dr. J. Gwyn Jeffreys, F.R.S., and Mr. David Robertson, F.L.S., for great and uniform kindness in naming the specimens submitted to them, which has been a great encouragement in our investigations. We have also to thank Mr. Kerr, the manager, and Mr. Peter Scott, the inspector of works, at Garvel Park, for kind assistance in various ways.

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*A List of Shells and other Organic Remains found in the Post-pliocene Clays at that part of Garvel Park, Greenock, referred to in the preceding remarks.*

PLANTÆ.

| | |
|---|---|
| *Algæ*—various species, | abundant in some places. |
| *Musci*—various species, | common. |
| *Chara*, sp. (?), | not very uncommon. |
| *Leaves of plants*, apparently coriaceous, | common and very perfect, but fragile. |

FORAMINIFERA.

| | |
|---|---|
| *Cornuspira* (D'Orb.), | |
| *foliacea* (Phil.), | common. |
| *Lagena* (Walker), | |
| *gracillima* (Seg.), smooth form, | not uncommon in some places. |
| *Marginata* (Mont.), | |
| var. *Orbignyana*, | rare. |
| var. (?) | rare. |
| *ornata* (Will.), | not uncommon, but easily overlooked. |
| *hexagona* (Will.), | not uncommon in the more sandy clay. |
| *caudata* (D'Orb.), | frequent; fine specimens. |
| *Dentilina* (D'Orb.), | |
| sp (?) | rare. |
| *Cristellaria* (Lamarck), | |
| *crepidula* (F. and M.), | rare. |
| *polymorphina* (D'Orb.), | |
| *acuminata* (Will.), | common. |
| *Globigerina* (D'Orb.), | |
| *bulloides* (D'Orb.), | frequent. |
| *Discorbina* (Parker and Jones), | |
| *Wrightii* (Brady), | not common. |

Starfish remains (not yet determined).

ANNELIDA.

*Spirorbis* (?) *Wattianus* (Scott).

CRUSTACEA.

OSTRACODA.

| | |
|---|---|
| *Cytheropteron* (G. O. Sars), | |
| *arcuatum* (B., C., and R.), | locally frequent. |
| *inflatum* (Brady), | frequent. |
| *Cytheridea* (Bosquet), | |
| *Sorbyana* (Jones), | common. |

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CIRRIPEDIA.

| | |
|---|---|
| *Balanus* (Lister), | |
| *porcatus* (Da Costa), | |
| var. *elongata* (?), | common. |

## MOLLUSCA.

CONCHIFERA.

| | |
|---|---|
| *Modiolaria lævigata* (Gray), | remarkably abundant, but very fragile. |
| *Dacrydium vitreum* (Torell), | frequent in some places. |
| *Nucula tenuis* (Mont.), | |
| var. *inflata* (Mörch), | common. |
| var. *sulcata* (?), | rare. |
| *Leda arctica* (Gray), | frequent. |
| *Axinopsis orbiculata* (G. O. Sars), | frequent. |
| *Astarte borealis* (Chemn.), | frequent. |
| *crebricostata* (Forbes), | frequent. |
| *Thracia truncata* (Brown), | not common. |
| *Lyonsia arenosa* (Möll.), | not very common. |
| *Saxicara rugosa* (Linné), | |
| var. *pholadis* (Jeffreys), | rare. |
| *Neæra subtorta* (G. O. Sars), | rare. |

GASTEROPODA.

| | |
|---|---|
| *Trochus umbilicalis* (Brod. and Sow.), | common, especially in the more sandy clay. |
| *Natica affinis* (Gmelin), | some specimens very large; some even with the operculum. |
| *Velutina undata* (Smith), | rare. |
| *Buccinum Grœnlandicum* (Chemn.), | not very common. |
| *Fusus Barvicensis* (Johnst.) (?), | one specimen. |
| *Bulla utriculus* (Brocchi), | not unfrequent. |
| *Utriculus obtusus* (Mont.), | |
| var. *turrita* (Möll.), | of frequent occurrence. |
| *Philine scabra* (Müll.), | rare. |
| *lima* (Brown), | rare. |
| *aperta* (Linné), | rare—found in the upper sandy bed near Garvel House. |

Some of the above have not before been recorded from Garvel Park, while others, though frequent in the clays here referred to, were rarer further to the west.

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## No. XXXII.—Cleaves Cove, Dalry, Ayrshire: its Exploration and History. By John Smith. With Plan and Sections. [Plates XI. and XII.]

[Read at an Excursion of the Society to Cleaves Cove, 16th June, 1883.]

### Introduction.

The extensive and interesting Ayrshire cavern, long known as Cleaves Cove, is situated on the southern side of a romantic glen on the Duisk Water, about a mile and a half above the junction of that stream with the River Garnock at Dalgarven, and a mile and three-quarters south-east from the Dalry station of the Glasgow and South-Western Railway. It is seven miles from the Ayrshire coast, and 170 feet above sea-level. The spot is rendered charming by the presence of a small waterfall, situated a short distance farther up the glen, and attractive to the geological eye by the mural face of an old limestone quarry, right in front of the principal entrance to the cave.

Having been familiar with this cavern from my schoolboy days, I had long cherished a desire to explore it to the "benmost bore." Had the traditions concerning it current in the district turned out to be true, this would have been no easy task. There was a story of a dog which, having gone into the cave after a fox, came out, after many days absence, at a place several miles distant. Another tale was that the poker in a neighbouring farmhouse having fallen into a crack at the side of the hearthstone, was believed to have found its way into the Cove by a fissure in the rock. Again, a piper who had gone into it playing his pipes, not being able to find his way out, was said to haunt the place; the distant skirl of his instrument being still audible on a calm day in the remote passages.

Some seven years ago I made a few cuts here and there into the deposits in several of the passages, and the results were such as to show me that a careful and thorough exploration would be a matter of no small interest and value. To make this it was needful to obtain the permission of Capt. Blair, R.N., of Blair, on whose lands the cave is situated. Through the kind offices of Mr. Alex. Robertson, Quarrymaster, Kilwinning, this was given, the only restriction made by Capt. Blair being that we were not to set the place on fire. The work was begun in January, 1883,

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and was carried on for five consecutive months at the rate of two and sometimes three nights a week. On my own part, and on that of the six volunteers who assisted me, night work was a necessity, but it was found to work well, as we were not in the smallest degree troubled by curious visitors, with perhaps one exception, when a bat got fast to the neck of one of the explorers, making him think for the time being that some uncanny denizen of the cave had come to claim his prey. I have now got Mr. "Baukie" in good spirits!

## Historical.

The oldest account of Cleaves Cove which I have met with is that given by Timothy Pont, A.M., in his MS. of "Cunninghame Topographized, 1604-1608," where he says: — "Dow-Visch-Banckes heir ther is a grate coue the inermost end quherof is not found it is by the vulgar named the Elffe housse being of a large bounds vithin."

In "Forsyth's Beauties of Scotland," 1805, the cavern is noticed thus:—"In the Parish of Dalry, on the side of a limestone rock, is a remarkable natural cavern. It is 44 feet above the bed of rivulet, is covered with 30 feet of rock and earth, and crowned with wood. The entrance is adorned with a vast prominent rock 27 feet broad and 30 feet long, sloping a little upwards. The internal structure is like gothic arched work, supported with many columns and buttresses. Its width varies in different places from 5 feet to 10 feet, its height from 5 to 12 feet, and its length is about 183 feet. About the middle of it is a spacious opening, 35 feet broad, 12 feet wide, and 12 feet high. The whole internal surface is variously indented, its floor is nearly dry, its sides and corners run off into many crevices, and its roof is emblazoned by calcareous incrustations." The measurements given in this account, however, have evidently been taken "by the eye," as they are far from being accurate.

George Robertson, in his "Topographical Description of Ayrshire," Irvine, 1820, notices the cave as follows:—"Singular Cave. —In the limestone rock on the bank of the Dusk, on the lands of Auchenskeith, there is a natural cave 185 feet in length, containing a number of rooms, some of them of large dimension. The inward structure is like gothic arched work, supported with many columns and buttresses. The roof is shining with calcareous incrustations,

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and in one side of the entry there is a vein of sulphate of barita ten inches in thickness." Probably stalagmite.

In the "New Statistical Account," Ayrshire, Dalry Parish, p. 211, we find the following description of the cave:—"On the estate of Blair, in the romantic and beautifully wooded glen of the Dusk, there is a natural cave in a precipitous bank of limestone. It is about 40 feet above the bed of the stream, and is covered by about 30 feet of rock and earth. It has two entrances. The western, or main entrance is situated below a vast overhanging rock, 30 feet long by 27 in breadth, the brow of which is covered by the mountain ash, hazel, and two large plane trees, which give it a picturesque appearance. Its interior resembles gothic arched work. Part of the roof is supported by two massy columns. Its length is about 183 feet, and breadth from 5 to 12. Near the middle it expands into a spacious chamber, 35 feet long by 12 broad and 12 high. Its internal surface is covered by calcareous incrustations, and numerous crevices branch off from its sides. In former times popular belief peopled it with elves. It consequently acquired the name of the 'Elfhouse.' In later days, during the tyrannical reign of Charles II., it afforded a hiding place to the Covenanters of this parish from the violence of their infuriated persecutors."

In the first printed edition of Pont's "Cunninghame," published by the Maitland Club in 1853, a plan (a very imperfect one) of "Cleaves Cove" is given, "as explored by torchlight by E. W. S., E. J., and W. S., on Saturday, 24th August, 1833." After quoting Pont's original observation, given above, it is remarked that "this cove, which is no longer the retreat of the elves, nor without being explored to the 'inermost end,' is one of the greatest natural curiosities in Ayrshire." And after quoting the description given in the "New Statistical Account" (see above), "the accompanying drawing shows the extent and tortuosities of this remarkable cave, so well suited as a retreat for fairies and persecuted men, now fortunately equally rare inhabitants!"

Before beginning the work we laid down a rule of procedure to be strictly followed in taking out the deposits layer by layer as they had been laid down, so that a correct tally might be kept of everything found, and its exact relative position noted. Very soon this was found to be impracticable from the fact that the second layer, which was composed of a dark-coloured vegetable

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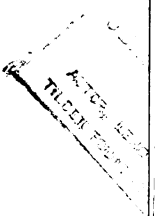

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mud, was so soft, that barrows and men began to sink into it. We then took the whole depth of the deposits in one face, working from top to bottom, and this arrangement worked admirably. The large ribs of the ox could be drawn from the muddy deposit like swords from their sheaths. After some little experience we found that all the bones in the upper deposit were white, while those from the second bed were brown, and in some cases almost black.

At the end of this paper I have added lists of all the animal and vegetable remains found in the cave, as well as of the implements and ornaments. I may say that the smaller objects, such as mosses, seeds, insects, &c., were collected by taking carefully selected samples of the deposits, and subjecting them to a process of washing and sifting.

## Exploration.

When the explorations were commenced, the entrance to the "Swinrick Room" was found to be closed by a mass of large stones and red earth, the whole being bound together by an infiltration of lime in the shape of stalagmite, and this obstruction was removed for the purpose of allowing the deposits in the higher reaches of the cave to be more easily taken out. Two of the entrances can be reached by climbing up the steep side of the glen. The "Grand Entrance," which is overhung by an immense mass of limestone rock bearing two goodly sycamore trees and a fine canopy of brushwood, is approached by the old quarry road, while the "Spy-hole Entrance," which is situated in the cliff of the limestone overhanging the glen, can only be got at by means of a ladder. The fifth has been probably shut for ages, and still remains so.

This remarkable cavern, which has been excavated by the slow but continuous action of natural forces, is hollowed out in the thick bed of limestone known as the Auchenskeith bottom post. A small fault at the "Grand Entrance" has thrown up the limestone to the north for a distance of about twenty feet higher than its position in the old quarry. This limestone is of a bluish colour, and has been worked at Auchenskeith and Auchenmade in the Dalry district, and at Broadstone, Gateside, and other places near Beith. Its position in the geological scale is some twelve hundred feet below the Main coal of the Western Ayrshire coal-

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field. The large fault, known as the Duisk Valley fault, which passes only a short distance in front of the cave, has let down the strata to the north-west, so that the coal seam already spoken of has been thrown down to nearly the same level as the limestone in which the cave is excavated. At this place we have ample proof of the denudation of at least two hundred fathoms of limestone and coal measure strata; and, as the Upper Carboniferous measures come on in regular sequence farther to the south, it is not going beyond the province of fair geological deduction to say that at one time this limestone was buried beneath all the Upper Carboniferous strata of western Ayrshire, and possibly other higher strata no traces of which now exist in the district.

My duty is now to discuss this queer Cove, to see how he came here, and to hear what he has got to say. The exhaustive examination of the contents of his stomach, which, by-the-bye, is some five hundred feet long, and from two to ten or twelve feet wide, has given us a clue to his history. Just let us step back, say a few thousand years, and plant our foot on the top of Baidland's snowy pow. I say snowy, for Baidland hill was at that time covered with perpetual snow, though it has now become green with years. We look towards the present position of Cleaves glen, but no glen is there, neither has the cave begun to exist. The Duisk Water is just beginning to find its way along the top of the now-completed deposit of the Boulder-clay. The great glacial ice-sheet has all but melted from the face of this part of Ayrshire. The Duisk continues its work of excavation in the Boulder-clay, and by-and-by reaches the top of the Cove limestone. But no cave yet. Time moves on, and water begins to find its way through the joints of the limestone, carrying with it a few traces of carbonic acid gas, picked up from the decaying vegetation along its course, or washed into it from the air by the rain-fall. This gas erodes the limestone along the sides of the natural jointings of the rock, through which the water "seeps," joining the stream farther down as hard water. A thin knife-blade could now be inserted between the jointings of the rock, and the Cove has begun to exist. Where there is room for a knife-blade there is space for fine particles of sand, the river furnishing these minute tools in plenty, and which, washed through the thin slits in the limestone made by the carbonic acid, aid it in widening the joints destined to be the future passages of the cavern. Gradually the openings, by

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the action of these agencies, were worn wide enough to admit small gravel, and "spates" in the Duisk began to play their part by rolling it through the passages of the embryo cave. Time did the rest, and the Cove became what we now find it, a splendid temple of "dollart" gothic architecture.

*Deposits.*—It was only by an exhaustive examination of the deposits found in the passages of the Cove that I was enabled to come to the conclusion that the Duisk Water, which now runs in the glen far below the level of any of the entrances, had at one time run through the passages and had been the means, in great measure, of scooping them out and of bearing in and leaving upon their floors the interesting deposits which enable us to read its history. These, in all the low-lying passages, with the exception of one, were distinctly in three beds. In the "Festive Hall," so-called from the great number of bones we found in it, the deposits reached the thickness of 3 feet 2 inches. The bottom bed was 14 inches thick, and was composed of sand and gravel mixed with clay, the clay having resulted in great measure from the decomposition of the gravel. All through this bed, which extended from the "Grand Entrance" to the middle of the "Swinrick Room," but was absent from the greater part of the "Dynamite Passage" and the "Blair Corridor," were large and small blocks of sandstone, whinstone, limestone, ironstone, and shale, all well water-worn. In this bottom bed no traces of man or his works were found, the only organic remains got in it being a few small bones of mammalia and rolled pieces of branches of trees. The bed on top of this—15 inches thick—was made up of vegetable mud; thin layers of sand, large and small water-worn stones of whinstone, sandstone, &c., being freely scattered through it. Its great and interesting features were the amount of organic remains, and the abundant traces of man's occupation of the cave, which it contained. Branches of hazel, alder, hazel nuts in abundance, seeds of various plants, and mosses in a fine state of preservation, wing-cases of beetles, land and freshwater shells, freshwater ostracoda, hundreds of mammalian bones, teeth, and jaws, and, to crown all, traces of man in the shape of rude implements in bone, and horn, and wood charcoal, the remains of fires he had lighted to cheer the winter nights or cook his food, were got in it. This middle bed extended from the "Grand Entrance," through "Adam's Lobby,"

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the "Festive Hall," the "Dynamite Passage," and the "Blair Corridor" to about the middle of the "Swinrick Room." Many of the bones from this bed have marks of some sharp instrument on them, and others have been broken and split longitudinally to get at the marrow. Many of them were gnawed as if by the teeth of animals. Many specimens of *Littorina littorea* were found in this bed, and a decayed fragment of *Pecten maximus*. It is noteworthy that no traces of any other edible shell-fish, nor any of the cereal grains, were found in this deposit. The examination of this cavern has shown me that the preservation of bones depends to a great extent on the material they have been lying in. Some of the bones on the surface of the dry passages, or a few inches below it, had apparently lost all their gelatine, for they were so light and porous that they adhered to the tongue, and floated on water; whilst those preserved in the fine clayey vegetable mud were hard and strong and heavy. No split bones were got in the top deposit, and the only traces of man were fragments of a rude black pottery which had been made on a potter's wheel and milk glazed, an iron spearhead, a brass ring, and a silver ring, all found within a few inches of the surface, and possibly trampled into their position whilst the surface was in a soft state, as it was before the explorations were begun, and the water drained off by the "Dynamite Passage" and the "Grand Entrance." This occupation of the cavern by man appears to have taken place when the waters of the Duisk no longer entered the Cove, when, in fact, the river had cut its bed too far below any of the entrances for even the highest floods to gain admittance to the passages. Should it be asked why the Cove did not continue to be deepened as well as the glen, the chief reason appears to have been that the "Grand Entrance," which was the exit for the stream from the Cove when the river ran through it, was worn down to the thick post of whinstone and burnt coal, which would offer great resistance to the action of the water. The removal of the deposits has shown us that the floors of the "Low-level Passage" and "Adam's Entrance" were actually worn about two feet lower than the "Grand Entrance," owing to the inclination of the limestone, which dips from the river about three feet lower than the original level of the "Dynamite Passage," where the river last entered the Cove. Had the limestone been of greater thickness

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than it is, the waters of the Duisk would in all probability have still been running through the Cove, and the heights of some of the passages would possibly have been three times greater than they are; but the hard and tough whin and burnt coal at the "Grand Entrance" prevented its being excavated as rapidly as the bed of the river outside, and the stream no longer getting access, a stop was put to its further increase in size by river action.

We naturally wonder where man found a place for the sole of his foot when the waters of the Duisk flowed through the cave at the period it was first inhabited by him. And the answer is—In some of the higher and therefore drier passages between the "Festive Hall" and the glen, and possibly in others which have now been destroyed by the deepening of the glen; for it appears certain that the Cove was at one period much larger than it now is. We see this clearly by the manner in which four of the side passages are open to their full size on the bank of the glen. The north-eastern passages—"Hunter's," "Niven's," "Baird's," "Napoleon's," "Longwell's," and "Silver Ring"—were possibly never inhabited by man, as he could only have entered them (after the deposits were laid down) on all fours, and the deposits taken from them showed no trace of man or his works. In fact, the deposits in all the high-level passages, which I consider to have been the oldest deposits in the cavern, showed no trace of man, and were composed throughout of reddish clay, mixed with large and small waterworn stones of sandstone, whinstone, ironstone, shale, &c., many of the stones being so much rotted and decomposed that, though preserving their shape, they could be crushed in the hand. The organic remains found in all the high-lying passages were either on or within a few inches of the surface, and were the remains of small animals which had probably been carried into the cave by foxes, &c., for food. "Longmuir's Passage," the most back-lying of all, and one which had evidently never been entered by man, even on all fours, before the deposits which reached to the roof at its entrance were removed, is a low-level passage, with shelving sides and fissured roof, but, unlike all the rest of the low-level passages, the bed of vegetable *debris* containing bones and rude works of human art, which was found in all the others, was absent from it. The deposits in this passage were composed of layers of fine sand and mud mixed with small rolled stones foreign to the cavern, and in the very centre of it was found a

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valve of the large Swan Mussel, *Anodonta cygnea*, specimens of which were also found in the "Blair Corridor" and the "Dynamite Passage." A large waterworn bone was got about the bottom of the deposits, near the centre of the passage. Blocks of decomposed or "sookit" limestone were found in all the passages, and in every part of the deposits were found large and small blocks of unrolled limestone, all composed of the rock through which the cave was worn, and having evidently fallen from the roof as the deposits were being laid down. They presented a decomposed or "sookit" appearance, as if they had undergone a process of digestion in the mouth of some ancient giant. Many such blocks had to be taken down from the roof during the process of exploration to ensure our personal safety. Is it too much to imagine that many of these blocks had been assisted to their restingplaces amongst the deposits by the shocks of earthquakes in former ages?

*Carboniferous Fossils.*—In every part of the deposits, fossil forms belonging to the orders Spongidæ, Foraminifera, Ostracoda, Polyzoa, &c., were sparingly found. These were true Carboniferous forms, which had fallen into the deposits from the decomposing limestone of the cavern, or which in some instances might have been washed in from Carboniferous strata farther up the river.

*Stalactites and Stalagmites.*—Every passage has or has had its stalactites. The roofs of some of the passages which were difficult to enter before the deposits were taken out were found to be bristling with them, and in many places conical stalagmites had grown from the floors of the passages, and had joined the stalactites growing downwards towards them from the roof. Some of these conical stalagmites told us a bit of the Cove's history. The interior of one was built up, layer upon layer, for two inches of its diameter, of the purest carbonate of lime. The outside half-inch was made up of thin layers of red earth and carbonate of lime, alternately. The interpretation I put on this is, that at some period after the deposits were laid down all the entrances to the Cove had got closed up by the clay and stones falling down over their mouths from the side of the glen. As I have already stated, two of the entrances were closed when we began operations, and one remains so still. During the period of closure the pure white interior of this stalagmite had been formed. But a time came when the river having washed away the base of the obstruction it slid down, and the entrance being once more opened, foxes or other animals gained

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admittance, and, passing and repassing this growing stalagmite, painted it with red earth, which in its turn was covered with the limestone solution from the roof. Owing to the strong current of water, which has passed through all the passages, no sheet of stalagmite had been allowed to form on the floors of any of the passages, but sheets of stalagmite have formed on their sides, some of them being of very fantastic forms. The most considerable piece of solid sheet stalagmite is that to be seen in the "Swinrick Room," and, curiously enough, it had been formed over the inside slope of the obstruction which closed the entrance to this room. A small sheet of spongy stalagmite, about four inches thick, was got at the end of the "Dynamite Passage." This also had been formed on the top of the cave deposits. On a sketch plan of part of Cleaves Cove, which is given in the edition of Timothy Pont's Cunninghame, edited by Mr. Shedden Dobie in 1879, the stalagmite in the "Swinrick Room" (there called the "Great Court") is set down as glittering rock. In all the deposits were found small white conical stalactites which had fallen from the roof through some cause or other. I have observed that there is a vast difference between stalactites and stalagmites. The stalactite, in its first beginnings, is hollow, and is lined with minute crystals. The point always remains hollow, and the interior gets filled up as it grows down from the roof. The conical stalagmite, on the contrary, is always solid, and is broader or narrower according to the amount of lime-water solution falling on it and the distance it has to fall. Sheet stalagmites may be either solid and crystalline, or semi-crystalline, or spongy, the spaces being lined with minute crystals, but how this structure has come about is not so easily explained.

*The Cove still getting larger.*—To look at the Cove in its present state one would at first glance think that all further development of the passages had ceased; but this is not the case. A small run of water has always been issuing from the cave, and this has been doing its work slowly, but surely and steadily, since the deposits were laid down in the passages. Some of the cracks or natural jointings of the rock were found to be open in the floors as much as two inches in width. Had they been open before the deposits were laid down they could not have failed to be filled up by the fine sand and mud carried in by the river. The joints in the roofs of the passages have also been widened, and this has possibly been going on since the Cove first began to exist; but it has proceeded

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at a very slow rate, the widest roof joint observed, where a stalactite was broken off, being only one-eighth of an inch across. To see this cavern in its present state of natural grandeur and solidity, hollowed in a great and strong post of solid rock, one would think it was destined to endure for ever. The elements—water and carbonic acid—which have made it, and furnished it with all its beauty of sculpturing, will assuredly sweep it from the face of the earth; but let us hope that the life of the old Cove, which may be said to have begun a new existence, will yet be extended to threescore and ten thousand years. But all Coves are mortal, "*alles irdische verhallt.*"

### Description of the Passages, Pillars, and Deposits.

*Grand Entrance.*—The principal opening into the cavern is overhung by a large mass of limestone rock, 18 feet long, 14 feet broad at the outside, and 25 feet broad at the inside, and its thickness, including the Boulder-clay, above 17 feet. After a depth of about 3 feet of rubbish which partly closed it was removed, the original floor of the cave was reached, and was found to be composed of a very tough mixture of greenstone and buried coal, which had to be blasted out to a depth of 18 inches to allow the accumulation of water to drain from this part of the cave. The dip of the rock at the "Grand Entrance" is 1 in 10 in the direction 61½° S.E.,* and before the floor was lowered it was 25 feet above the bed of the Duisk Water in the glen beside it.

*Adam's Lobby.*—The bearing of this passage is 75¼° S.E. The length is 25 feet, and the width next the "Grand Entrance," 8 feet 6 inches, height at same place 10 feet 2 inches, tapering to 7 feet 3 inches at the further end. The roof of this passage is for the first half rather flat, the rest being cut into with a deep fissure. The south wall is indented by several finely sculptured fissures, and the north side is bounded by "Pont's Pillar" (which has a deep forked gash), "Agassiz' Passage" and "Robertson's Pillar." The sculpturing on the south wall of "Adam's Lobby," and on the above-named pillars, is strong and bold, and the lean of the passage is slightly to the south. The deposits found in this passage were—

| | | |
|---|---|---|
| Reddish earth, with a few small *white* bones, ... ... | | 10″ |
| Dark vegetable muddy clay, with many large *brown* bones and wood charcoal,... ... ... ... ... | 1′ | 2″ |
| Gravel, ... ... ... ... ... ... ... ... | | 9″ |
| | 2′ | 9″ |

* All the bearings are magnetic. September, 1883.

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A fragment of *Pecten maximus* and a finely made bone chisel were got in the middle deposit, and large rolled and well-rounded pebbles of sandstone, dolerite, clay-band ironstone, shale, &c., were common throughout every part of it. All the large bones were broken and split for the marrow, many of them having knife-like marks, and some of them being considerably gnawed.

*Festive Hall*—Leaving "Adam's Lobby" and turning to the left, we find ourselves in the great "Festive Hall." From "Robertson's Pillar" to the side of the "Dynamite Passage," this hall is 24 feet long, it is 13 feet wide opposite "Boyd Dawkins' Pillar," and 10 feet wide at "Cochran-Patrick's Pillar." The height near "Robertson's Pillar" is 8 feet, and next the "Dynamite Passage" 6 feet 9 inches. The bearing is $76\frac{3}{4}°$ S.E. The floor rises pretty steeply towards "Boyd Dawkins' Pillar," and dips gently towards the "Dynamite Passage," where there is a depression in which a small pool of water forms. At the S.E. corner is "Hope's Nose," a small boss of limestone which rises up from the floor. The roof of the "Festive Hall" is, generally speaking, flat, dips gently towards the S.E., and is indented with a deep fissure. The sculpturing of the south side, and the side of "Cochran-Patrick's Pillar" opposite, is peculiarly irregular. A bed of calcareous shale 8 inches thick is seen at one foot below the roof, and several thin reefs of *Lithodendron* occur in this passage. The middle part of the deposits here contained an immense quantity of large brown and blackish bones, and a large tine of a deer's horn which had been sawn—possibly with a stone—on both sides and broken off in the middle, its surface being roughly polished. It is easy to see how this passage came to have such a large quantity of bones (many of them split and gnawed). When the waters of the Duisk were flowing through it, the cave-dwellers would find a high and dry seat at the south end of "Boyd Dawkins' Pillar," and in the passages on each side of it. After they had consumed the meat and marrow the bones were thrown into the pool of water, along with the shells brought from the sea-shore, to be covered up by the stones, mud, sand, branches, nuts, &c., carried in by the stream, and by the large blocks of limestone which occasionally fell from the roof. The section of the deposits in the "Festive Hall" was similar to that in "Adam's Lobby," and only 1 inch less in depth. For a few feet in breadth along the south wall the deposits were composed of very fine mud intermixed with branches, nuts and

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bones. This mud is easily accounted for, as from the width of the passage this portion of it would be out of the current of the water, and so would give a quiet settling-place for the muddy water. Some of the large stones in the centre of the passage, on the other hand, were over 2 cwts. in weight.

*Dynamite Passage* is at the east end and to the left of the "Festive Hall." Its bearing is 7° N.W. Its length is 50 feet from the "River Entrance" to the beginning of "Longmuir's Passage." On the east side is the "Duke of Argyll's Pillar," the "Blair Corridor," and "Owen's Pillar." On the west side, "Cochran-Patrick's Pillar," "Hugh Miller's Passage," "Pengelly's," "Buckland's," and "Croll's Pillars." Its width opposite "Croll's Pillar" is 5 feet, and opposite the "Duke of Argyll's Pillar" 9 feet. The height at the entrance is now 11 feet (formerly 8 feet), the floor, for a depth of 3 feet there, and 1 foot at the "Festive Hall," having been blasted out with dynamite to allow the water to drain off. Its roof, from the entrance to opposite "Hugh Miller's Passage," is pointed gothic, and the walls are beautifully and strangely sculptured. The side of the "Duke of Argyll's Pillar" next this passage is deeply indented with three finely-moulded "aumries" or recesses cut into it obliquely. The deposits at its south end were similar to and continuous with those in the "Festive Hall." A large bone, with a nick formed all round it near one end, and roughly polished, and the butt-end of a deer's horn, which had been sawn across and roughly polished, were got in the middle portion of this part of the passage, and opposite to the "Blair Corridor." An iron spear-head was also found a few inches below the surface, having possibly sunk or been trampled into its position. Another iron or steel spear-head was got from the *debris* which has been removed from this passage, but, of course, it was impossible to say from what part of the deposit it had come. Next the inner end a large valve of the Swan Mussel, *Anodonta cygnea*, was got in the middle part of the deposit, along with large bones, and specimens of *Buccinum undatum*. The deposits gradually thinned away towards the "River Entrance," which for a few feet was free from them, the only place in the Cove where the floor was bare when I commenced explorations. In the middle of the passage, and opposite "Hugh Miller's Passage," the section of the deposits was—

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| | |
|---|---|
| Yellowish tough clay, ... ... ... ... ... | 8″ |
| Vegetable *debris* and mud with large bones, ... | 4″ |
| Yellowish tough clay, ... ... ... ... .. | 3″ |
| | 1′ 3″ |

*Blair Corridor.*—Opposite "Cochran-Patrick's Pillar," and bearing 73° N.E., is the splendid "Blair Corridor." Its length, from the "Dynamite Passage" to the "Swinrick Room," is 41 feet 6 inches; at the "Dynamite Passage," width 4 feet 9 inches, and height 7 feet; at the "Swinrick Room," width 7 feet, and height 8 feet. The floor is traversed for its entire length by a deep gutter 2 to 4 inches wide, which was open when we removed the overlying deposits, having evidently been dissolved out since they were laid down, otherwise the fine mud and sand would have filled it up. From the "Dynamite Passage" a small upper passage, right above the "Blair Corridor," runs for a short distance, and was found of use as a hiding-place for the tools when our explorations were being carried on. The roof of this fine passage is deeply fissured, and the walls are exquisitely sculptured in what I have called "dollart" gothic. On the north side of the "Blair Corridor" are two thin pillars, "Wallace" and "Bruce," separated from "Owen's Pillar" by two very narrow passages. These three pillars are exquisitely moulded and banded by some fine coral reefs of *Lithodendron*, which, of course, are more or less seen all through this passage. Between these pillars, at a height of 5 feet 5 inches above the floor of the "Blair Corridor," is a small high-level passage 18 inches high by 12 inches wide, running in a N.W. direction into "Owen's Pillar." On the south side of the "Blair Corridor" four beautiful "wall-presses" are cut into the "Duke of Argyll's Pillar," and on the north side "Owen's Pillar" is indented by two other recesses. At the S.E. corner, another small high-level passage is seen running in a N.W. direction into "Owen's Pillar." The deposits at the "Dynamite Passage" end of the "Blair Corridor" were only 9 inches deep, but they gradually deepened towards the "Swinrick Room," where the section was as follows :—

| | |
|---|---|
| Yellowish tough clay, ... ... ... ... ... | 9″ |
| Dark clay, with large bones and branches, ... ... | 8″ |
| Gravelly clay, with a few rotted sticks, ... ... | 8″ |
| | 2′ 1″ |

The middle part of the deposit here was very tough, and difficult



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to detach. A second valve of *Anodonta* was got in it. After the deposits were removed, and the passage was being swept, a rude bone ring was found. The last 10 feet of the floor towards the "Swinrick Room" dipped 6 inches, and in this part water lay, but was let off, as will be seen in the description of the next passage.

*Swinrick Room.*—This is the only passage in the Cove to which tradition has given a name. It is said that several hundred years ago, the then Laird of Swindridgemuir took up his abode in this passage, which at that time, and until we commenced explorations, was closed at its northern entrance by a mass of limestone blocks and *debris*, all bound and cemented together by stalagmite. "Auld Swinrick," whom tradition credits with being a little "wud," is said to have lived for some time here till his friends came and took out his bed and furniture, and burnt them in the glen. A fault runs along the S.W. side of this "Room," and right through "Baird's Creep," bringing up the intrusive greenstone which lies below the limestone, so that the floor of this passage, which dips 1 in 8, in the direction 44° S.E., is composed of greenstone, and in this respect is different from the floors of all the other passages, except that of the "Grand Entrance," they being of limestone. The "Swinrick Room" bears 35° N.W., is 34 feet long, 12 feet wide next the river, and 9 feet between "Owen's Pillar" and "Ure's Pillar." The height, at the "River Entrance," up to what remains of a large sheet of solid banded stalagmite, which was spread over the inner slope of the obstruction, is 6 feet 4 inches, and opposite the "Blair Corridor" the height is 10 feet 6 inches. The roof is very irregular and deeply fissured, and a deep gutter runs along the S.W. side of the floor in the line of the fault, which, after being cleared out, allowed the water, which had accumulated at the N.E. end of the "Blair Corridor," to run freely away. The greenstone floor is partly covered with a patch of burnt coal 3 inches thick, and above the coal a band of soft calcareous shale, with *Productus* and other fossils, is seen cropping out on the east side. Portions of the obstruction on each side of the entrance still remain. In mining through it, some exquisite specimens of stalactites and stalagmites were found amongst the large blocks of limestone, and several specimens of *Helix nemoralis* were got embedded in the stalagmites. We were here reminded of the strongly disintegrating powers ascribed to roots. Had any strong advocate of the root theory been with us

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when making this cut he would have been quite as favourably impressed with their preservative qualities. Many tons of loose earth are held together on the steep bank of the glen by the roots, the finer fibres forming quite a network which holds together the finest particles of soil. In fact, if it were not for them all the soil of the bank would be swept into the river below by the rains of a single season, leaving the bare rocks below to be acted on, and more rapidly disintegrated, by the sun, air, frost, and rain. No doubt, roots act as powerful disintegrating agents in breaking up rocks, but on the other hand we are convinced their preservative qualities are greatly in excess of their destructive ones. The deposits of the S.E. part of the "Swinrick Room" were continuous with those of the "Blair Corridor," and measured as follows:—

| | | |
|---|---|---|
| Reddish earth, mixed with yellowish clay, ... | 1′ | 0″ |
| Dark mud, with large brown bones and branches, | 1′ | 3″ |
| Stones and gravel,... ... ... ... ... | 0′ | 3″ |
| | 2′ | 6″ |

The middle and bottom beds extended no further than from the middle of the "Room," to where the "tail" of the obstruction reached. A brass finger ring of rude workmanship was got three inches below the surface in this passage.

This finishes the description of the passages in which the large bones carried into the cavern by man, and covered by the deposits of mud and rolled stones laid down by the waters of the Duisk, which now flow so many feet below its lowest entrance, and the rude implements of bone, horn, and stone used by him, were found. The deposits of mud and vegetable *debris* in which these remains have been so well preserved are absent, as I shall show, from all the other passages.

*Longmuir's Passage.*—Turning to the left at the south end of the "Dynamite Passage," we enter "Longmuir's Passage," which for the first half of its length bears 76½° S.E., and for the rest 86° S.E., the total length being 47 feet 6 inches. On the N.E. side it is bounded by the "Duke of Argyll's Pillar," and on the S.W. side is "Kent's Hole," a small unexplored passage, which seems to point to other narrow passages or fissures similar to those between "Croll's," "Buckland's," "Howe's," and "Pengelly's" pillars. The width of this passage next the "Dynamite Passage" is 3 feet 9 inches, and at the beginning of "Hunter's Incline"

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5 feet 6 inches. The heights at these respective places are 4 feet 7 inches and 4 feet 3 inches. The roof is deeply fissured, the opening in two places passing above as an upper passage. In this fissure and upper passage some splendid conical stalagmites, with their overhanging stalactites, in some places joined to them, were got, and many are still to be seen. Owing to the thin beds of impure limestone and shale which dip from the roof of the "Blair Corridor," and crop out in the sides of this passage, the sides bulge out so that it is difficult to pass along it. The sculpturing of the sides and roof is extremely rugged and irregular, but the floor, on the other hand, is smooth and polished. The section of deposits at the N.W. end was—

| | |
|---|---|
| Yellowish clay and rolled stones, ... ... ... | 2″ |
| Spongy stalagmites, ... ... ... ... ... | 4″ |
| Dark mud and rolled stones, ... ... ... ... | 9″ |
| | 1′ 3″ |

The stalagmite in this section was the only patch found imbedded in the deposits, and possibly points to a time when "Longwell's Entrance" was temporarily closed. Near the middle of the passage the deposits measured 3 feet deep, and were made up of yellowish, reddish, and dark-reddish mud, with thin layers of pure white sand and water-worn stones foreign to the Cove, and the usual blocks of rotted limestone which are common to the deposits of all the passages. Right in the centre of the deposits was a valve of *Anodonta cygnea*, the calcareous part being in a very soft state, but the epidermis still pliable. A wasted fragment of a pretty large bone was got near the bottom of deposit, and on the surface were numerous small white bones and many conical stalagmites. Under the shelvings of the impure limestone in some parts, and on the top of the river deposits, were exceedingly bright vermillion and blackish layers of impalpable mud, which were nowhere else seen in the Cove.

*Hunter's Incline*, continuous with "Longmuir's Passage," and bearing 55½° N.E., is 22 feet long, 5 feet 7 inches broad next "Longmuir's Passage," and 4 feet 8 inches next "Baird's Creep," the respective heights at these places being 4 feet 8 inches, and 3 feet 3 inches. The roof, at the S.W. end, is deeply fissured, the sides being formed like the stone seats of a "slype," and roughly sculptured. A bed of shale 10 inches thick runs along the sides about midway betwixt floor and roof. From "Longmuir's Passage" to "Baird's

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Creep" the floor of "Hunter's Incline" rises 3 feet 11 inches. The deposits at the lower end were 3 feet deep, and were similar to those in "Longmuir's Passage." At the higher end they were only 12 inches deep, composed of red clay and rolled stones. Near the surface of the deposit were a great many fresh-looking but empty chrysalids of a dipterous insect. It is curious to think of a fly coming so far into utter darkness for the purpose of laying its eggs amongst the putrid *debris* the foxes had carried into this safe retreat. The surface of the deposit was also covered with rounded pieces of hard red clay about 1 inch in diameter. They are very odd-looking objects, and not easily accounted for. Possibly the foxes, in crawling out and in over the surface of the moist red clay, had something to do with their formation. On the S.E. side at the top and bottom of the passage are two narrow slits, which possibly connect with "Kent's Hole." Some of the patches of stalagmite lying on the surface of the deposits contained numerous bones and teeth of small animals.

*Baird's Creep*, between the N.E. end of "Hunter's Incline" and the S.E. end of the "Swinrick Room," is a low-roofed passage, with three long narrow pillars, one of them now removed. The two remaining ones I have called "Dick's" and "Edward's" pillars. The "Creep" is formed in the line of the fault which runs along the S.W. side of the "Swinrick Room." At the N.W. end the floor rises abruptly 3 feet 9 inches above that of the "Swinrick Room," and the width and height are there 4 feet 8 inches and 4 feet 4 inches respectively. At "Edward's Pillar" there is just sufficient space for a man to crawl through. Two small high-level passages near the N.W. side, the one 15 inches high by 7 inches wide, and the other 15 inches high by 10 inches wide, run respectively N.W. and S.W. into the "Duke's Pillar." The view of this passage from the "Swinrick Room" is very fine, the sculpturing being wild and fantastic. The S.W. side is bounded by the "Duke of Argyll's Pillar," and the N.E. by "Robert Craig's Pillar," "Napoleon's Elbow," "Page's Pillar," and "Dr. Munro's Passage." The deposits of this passage, which were not all removed, were 12 inches deep, and were composed of red clay and rolled stones.

*Dr. Munro's Passage* runs from opposite "Edward's Pillar" in the direction of 62° N.E. It is 17 feet long, 4 feet 7 inches long, and 3 feet 3 inches broad at S.W. and N.E. ends respectively,

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the heights at these places being 3 feet 5 inches, and 2 feet 6 inches. The sculpturing is bold and rugged, and a bed of *Lithodendron* is seen with the coralites in fine relief. Beautiful stalactites bristled from the roof of this passage when first explored, and many still remain. A few were got with projecting spurs, and, curious to say, some of these spurs curved out and pointed upwards. Near the S.W. end there is a pot-hole in the floor, which was filled with stones and gravel. The deposits were 15 inches thick, and were composed of reddish clay mixed with rolled stones foreign to the cave.

*Niven's Passage.*—Turning from "Dr. Munro's Passage" to the left, we enter this passage, which bears 26° N.W. and then 11° N.W. Its length is 35 feet; next "Longwell's Entrance" the width is 6 feet 3 inches, the rest being about 3 feet 5 inches. The height opposite "Napoleon's Elbow" is 4 feet, and at "Dr. Munro's Passage" 3 feet 5 inches. The continuation towards S.E. is open, and possibly joins with the other open fissures we have already noticed. The N.E. wall is deeply indented with seven waterworn fissures, which cut into it at various angles, and one of these has a raised rounded boss of rock at the entrance, and holds water. The S.W. side is bounded by "Dr. Munro's Passage," "Page's Pillar," "Napoleon's Elbow," and "Geikie's Pillar." The sculpturing of this passage is rather smooth and plain. A fine example of "undercut" is to be seen opposite "Napoleon's Elbow." The stalactites were very numerous, and one broken from the longitudinal fissure of the roof showed that it was $\frac{1}{8}$ inch open. The reddish clay, with rolled stones and limestone blocks, averaged 18 inches thick.

*Napoleon's Elbow* runs from "Baird's Creep" to "Niven's Passage," and I have so called it from a coin of the Emperor having been got lying on the surface of the deposit. The direction is first $25\frac{1}{2}°$ N.E., then $89\frac{3}{4}°$ N.E. The length is 19 feet, the width next "Baird's Creep" 2 feet 7 inches, next "Niven's Passage" 3 feet 6 inches, and the height at these respective places 4 feet 3 inches and 4 feet 9 inches. A deep gutter runs in the floor and a fissure in the roof, and the sculpturing is mild and flowing. On the S.E. side is "Page's Pillar," and to the N.W. "Geikie's" and "Robert Craig's" pillars. A narrow fissure, 8 feet high, and slightly zigzag in section, runs from "Napoleon's Elbow," between "Robert Craig's" and "Geikie's" pillars, to the S.E. end of the "Swinrick Room." When the dynamite shots were fired to remove

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the narrow pillar at the N.W. end of "Blair's Creep," 46 small stalagmites fell from the roof of this fissure. These were from 1 inch up to 3½ inches long; 26 being hollow, nearly parallel, tubes about ¼ inch diameter outside, and having one side thick and the other thin, the interior being lined with crystals, and the outside pretty smooth. Those which are not hollow throughout (for all the stalactites we have seen are hollow at the lower end) are more or less rough on the outside. The deposits in the S.W. part of "Napoleon's Elbow" were peculiar, the section being—

| | |
|---|---|
| Light reddish clay and stones, ... ... ... | 9″ |
| Dark reddish clay and stones, ... ... ... | 6″ |
| Rock Milk, ... ... ... ... ... ... | 3″ |
| | 1′ 6″ |

*Silver Ring Passage* runs from the S.E. end of the "Swinrick Room" to the S. end of "Longwell's Entrance." It bears 49° N.E., is 20 feet 6 inches long, 3 feet broad at S.W. end, and 5 feet broad at N.E. end, the heights at these respective places being 9 feet and 5 feet. On the S.E. it is bounded by "Geikie's Pillar," and on the N.W. by "Ure's Pillar" and "Bennie's Passage."

*William Smith's Pillar and Lyell's Pillar.*—Between these a long narrow fissure, with fine stalactites, runs from near the N.E. corner of the "Silver Ring Passage" to the "Swinrick Room." Two large pendant blocks of limestone hang from the roof near the S.W. end, and the floor at the same place rises abruptly 3 feet above that of the "Swinrick Room," and is deeply guttered all along. One short spur runs into "Ure's," and three into "Geikie's" pillars. At the corner, between the "Silver Ring Passage" and "Niven's Passage," was a large projecting boss of rock, now removed. The walls of the higher part were pretty much plastered with stalagmite, some of it taking a cock's-comb form in projecting, wavy, perpendicular ribs. The section of the deposits was—

| | |
|---|---|
| Reddish clay, with small stones and limestone blocks, ... | 1′ 2″ |
| Dark reddish gravel mixed with clay, rolled blocks of dolerite, sandstone, &c., the surfaces of many of them being much rotted, ... ... ... ... ... ... | 2′ 3″ |
| | 3′ 5″ |

A silver ring was found here a few inches below the surface.

*Longwell's Entrance* runs from the N.E. end of the "Silver Ring Passage," and bears 9° N.W. The N. end, which terminates

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in the steep side of the glen, has not yet been opened out. The probable length is 26 feet, the width at the S. end 9 feet 2 inches, and height 6 feet 4 inches. Close to the W. side a deep fissure cuts into the roof, and is plentifully furnished with stalactites. The floors of all the passages are more or less guttered, the gutters running in the lines of original cracks in the limestone. Many of these cracks are curved, but some are shown curved on the plan, which curving is caused by the inclined outcrop of a straight crack on a curved surface. As will be seen from the section (Plate XII.) the floor of this passage is excessively guttered. At the south end is a large pendant block of limestone, which appeared as a pillar before the deposits were removed. The deposits were similar to those in the "Silver Ring Passage," the section being—

| | |
|---|---|
| Reddish clay and rolled stones, ... ... ... ... | 1′ 8″ |
| Dark reddish clay, rolled stones, and blocks of "sookit" limestone, ... ... ... ... ... ... ... | 1′ 6″ |
| | 3′ 2″ |

An open fissure cuts into the east wall near south end, and the west side of the passage is bounded by "Lyell's Pillar."

*Bennie's Passage* runs from the "Swinrick Room" to near the middle of the "Silver Ring Passage." The bearing is 71½ S.W. "Ure's Pillar" is on the S.E. side, and "William Smith's Pillar" on the N.E. side. The length is 10 feet, the height 3 feet 4 inches, and the width 3 feet 6 inches, the cross section being roughly circular. The floor rises in a steep irregular slope 4 feet 3 inches above that of the "Swinrick Room." There is a high fissure in the roof of the N.W. end, with stalagmite flowing down its sides, and long pendants of the same hanging from the centre, the whole being exceedingly bright and sparkling. On the left side above the fissure is a high-level passage 6 inches wide, by 3 feet 5 inches in height, running into "Lyell's Pillar." The deposits in "Bennie's Passage" were similar to those in the "Silver Ring Passage." Small lumps of Rock Milk were got in the reddish clay near the surface.

*Hugh Miller's Passage* lies between "Pengelly's Pillar," and "Cochran-Patrick's Pillar." The bearing is 85½° N.W., the length 14 feet, the width next the "Dynamite Passage" 4 feet 2 inches, and at the opposite end 3 feet. A small upper passage runs right above the main passage. The floor rises abruptly 3 feet above the ori-

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ginal level of the "Dynamite Passage." The view of the entrance to this passage, looking from the S.W. end of the "Blair Corridor," is very fine, the sculpturing on the right-hand side being sharp and deeply cut, that on the left dimpled and smiling. The deposits in this passage were dry red clay and stones 15 inches deep. In all the other passages we have described the deposits were more or less wet.

*Agassiz' Passage* curves round the N.W. end of "Robertson's Pillar," its length being 13 feet, height 7 feet 9 inches, and width 4 feet 9 inches. A narrow fissure runs from N.W. corner between "Pont's" and "Murchison's" pillars, and an open fissure cuts into "Murchison's Pillar." The view of this passage and "Robertson's Pillar," looking from S.W. corner of "Cochran-Patrick's Pillar," is one of the finest in the Cove. Deposits in the lower part were similar to those in "Adam's Lobby," and in the higher part like those in next passage.

*Linnæus' Passage* bears 24° N.W., and a narrow slit in the same direction runs between "Murchison's" and "James Thomson's" Pillars, and terminates in the limestone cliff on the side of the glen. Through this slit a small beam of light enters the "Festive Hall" during the day, the whole distance being 27 feet 6 inches. At S.E. end the width and height are 5 and 6 inches (width taken at half-way to roof), and 7 feet at the N.W. corner of "Boyd Dawkins' Pillar," the width and height are respectively 1 foot 10 inches, and 5 feet 6 inches. Deposits were two feet deep, and similar to the dry deposits in "Hugh Miller's Passage." A large piece of splendid stalagmite was detached from the south end of "James Thomson's Pillar," and it has a wavy, "pipit"-looking surface. A fragment of milk-glazed, wheel-turned pottery was got near the surface, and similar pieces were got in several other passages in a like position.

*Landsborough's Passage* runs between "Thomson's Pillar," and "Cuvier's," and "Boyd Dawkins'" pillars. It is quite a curving passage, and terminates in the cliff of the glen. Its length is 18 feet, width 2 feet to 2 feet 3 inches, and height 4 feet 2 inches to 5 feet. The deposits were 12 inches deep, and similar in character to the last.

*The Treasury* can only be reached by creeping or squeezing through "Lubbock's," "Pander's," or "Evans'" Passages. It is safely surrounded by "Cuvier's," "Serres'," "Werner's," "Howe's,"

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"Pengelly's," and "Boyd Dawkins'" pillars, the passages and fissures which separate these pillars being very narrow. Its length is 10 feet, width 2 feet 2 inches, and height 5 feet 3 inches. The deposits and fallen blocks of limestone have not been removed from it, and it is our intention to let it remain in its original state. The corners and sides are beautifully moulded with stalagmite like Carrara marble, and look as if molten wax had been poured over them.

## LISTS OF THE VARIOUS OBJECTS OF INTEREST FOUND IN CLEAVES COVE.

In the identification of many of the organic remains found in the Cove I have been kindly assisted by the gentlemen whose names I have appended to the separate lists, and to them my thanks are therefore heartily rendered.

### Implements, Weapons, and Ornaments.

From surface deposit:—

Silver ring.
Finely cut glass bead of an emerald colour.
Bronze (?) finger ring.
Iron spear head.

From second deposit:—

Tine of red deer's horn, 10½ inches long; had been sawn on opposite sides to a small depth and then broken off; roughly polished all over the surface.
Part of base of red deer's horn formed into an implement, and polished all over the surface.
Small bone implement, chisel-pointed.

Of unknown position:—

Two bronze (?) finger spiral rings of three twists each.
Finely made bone spoon with circular bowl, shaft broken.
Peculiar implement, 3½ inches long, with oblong hole in centre, and circular hole running through it lengthwise. Made of endogenous wood.
Rude bone ring, possibly from second deposit.

### Minerals.

*Vivianite.*—In small blue patches on the bones, and in small masses in the interior of rotted branches.

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*Arragonite.*—Crystallized on the surfaces of the bones in small radiating patches.

*Rock Milk.*—A layer three inches thick was got beneath the deposits in "Napoleon's Passage," and in several of the other passages this substance was found surrounding blocks of limestone in the deposits. In "Bennie's Passage" and "Silver Ring Passage" small isolated pieces about an inch or less in diameter were got, and many of the fallen stalactites dug from the deposits were partly converted into this substance.

## Mosses.

For this list of Mosses from the middle deposit I am indebted to the kindness of the Rev. J. Ferguson, Fern, Brechin :—

*Thamnium alopecurum.*
*Hylocomium splendens.*
,, *triquetrum.*
*Aulitrichia curtipendula.*
*Eurhynchium Swartzii.*
,, *myosuroides.*
,, *striatum.*
*Brachythecum rivulare.*
,, *velutinum.*
,, *pluviosum.*
*Thuidium tamariscimum.*
*Neckera complaceata.*
*Ulota crispa.*
*Aulacomnium palustre.*
*Sphagnum cymbifolium.*

A few species remain undetermined.

## Seeds.

For the following list of Seeds from the middle deposit I am indebted to Mr. Thomas King :—

| | | |
|---|---|---|
| *Ranunculaceæ.* | One species. | Frequent. |
| *Papaveraceæ,* | ,, ,, | ,, |
| *Polygonaceæ.* | ,, ,, | ,, |
| *Labiatæ.* | Two species. | Rare. |
| *Caryophyllaceæ.* | ,, ,, | ,, |
| *Leguminaceæ.* | One species. | ,, |
| *Compositæ.* | ,, ,, | ,, |
| *Cyperaceæ,* seeds and fruit. | Two species. | Frequent. |
| *Graminaceæ.* | One species. | ,, |
| Three species undetermined. | | Rare. |

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## Shells.

Mr. David Robertson, F.L.S., F.G.S., has kindly sent me the following lists of Shells from the middle deposit :—

OSTRACODA.

*Candona candida.*

MOLLUSCA.

| | |
|---|---|
| *Sphærium corneum*, Lin. | Frequent. |
| *Pisidium fontinale*, Drap. | Rare. |
| *Planorbis glabra.* | Frequent. |
| *Zonites fulvus*, Mül. | Rare. |

The following were also got :—

| | | |
|---|---|---|
| *Anodonta cygnea*, Lin. | Three specimens. | |
| *Helix nemoralis*, Lin. | | Frequent. |
| *Pecten maximus*, Lin. | One valve. | |
| *Littorina littorea*, Lin. | | Frequent. |

The two last were taken in by man.

## Insects.

Mr. James J. King has furnished me with the following information as to the remains of Coleoptera found in the Cove :—

*Geotrupes.*
*Curculeo.*
Remains of about a dozen other species.

Mr. King remarks that the beetles to which the fragmentary remains belong are very difficult to make out even when one has the complete insect to work from.

Two kinds of sand-built cases, probably of dipterous larvæ, were found in the middle deposit, one straight, the other tapering and curved like a small *dentalium.*

Dipterous cocoons were frequent.

## Mammalia and Birds.

For this list I am indebted to the kindness of Dr. John Cleland, Professor of Anatomy in the University of Glasgow :—

BONES FROM SURFACE DEPOSIT.

| | |
|---|---|
| *Sheep.* | Both slender-legged and modern varieties. |
| *Hare.* | Left pelvis, left tibia, and right femur only. |
| *Rabbit.* | Frequent. |

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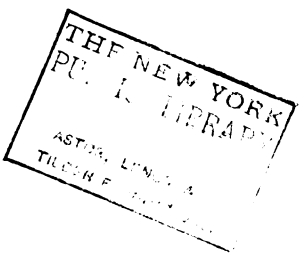


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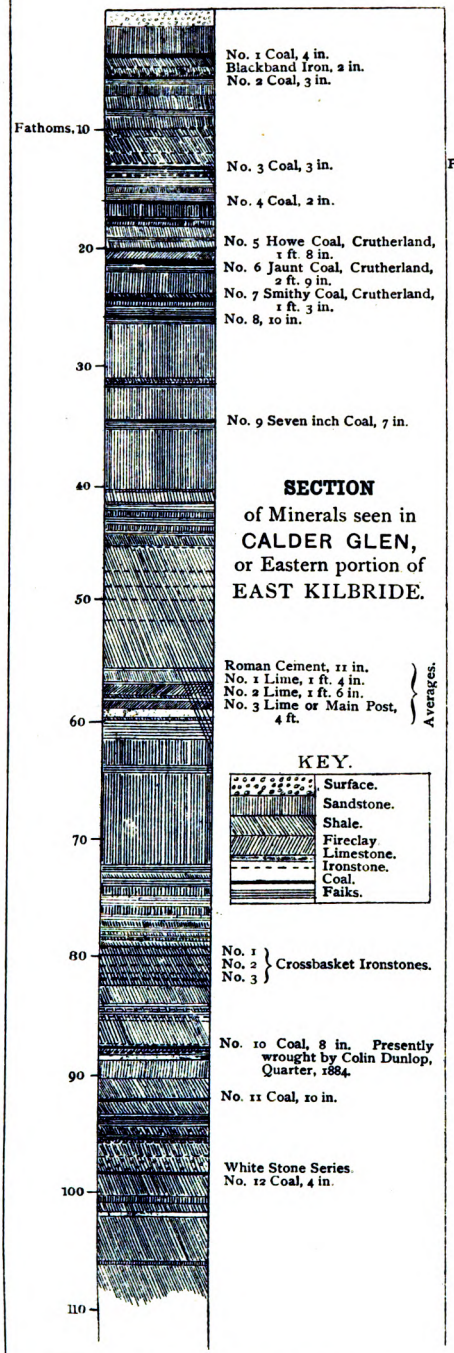


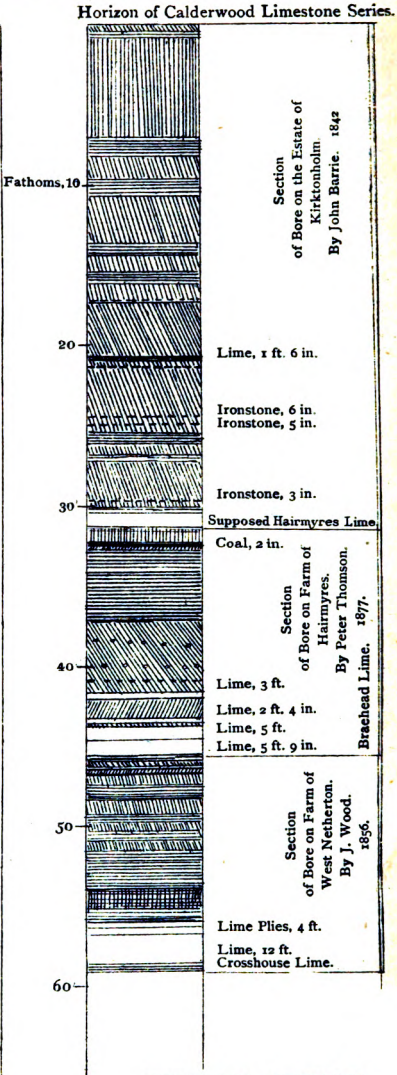


**VERTICAL SECTION**
showing the Minerals
found in the Western
portion of
EAST KILBRIDE.

Andrew Patton del.

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M.c Farlane & Erskine, Lith.rs Edin.r

| | |
|---|---|
| *Rat.* | |
| *Cat.* | A few bones. |
| *Dog.* | Small size, a few bones. |
| *Weasel.* | A few bones. |
| *Pheasant.* | A few bones. |
| *Partridge.* | A few bones. |
| *Duck.* | A few bones. |
| *Common fowl.* | A few bones. |
| *Goose.* | A few bones. |
| *Gallinaceous bird.* | |

BONES FROM MIDDLE DEPOSIT.

| | |
|---|---|
| *Ox.* (*Bos longifrons*). | Very plentiful. A number of the ox bones have belonged to very small individuals. |
| *Calf.* | Frequent. |
| *Red Deer.* | Tine of horn and case of horn only. Both specimens as implements. |
| *Sheep.* | Very plentiful. The majority of the bones have belonged to the slender-legged variety. |
| *Goat.* | Few bones of the goat found. |
| *Pig.* | Numerous bones of pigs. |
| *Beaver.* | Left lower jaw only. |
| *Badger.* | Left humerus only. |
| *Cat.* | A few bones got. |
| *Hare.* | Left humerus only. |
| *Goose.* | Left ulna only. |
| *Cetacean* (?). | Right rib. |

A large quantity of bones, jaws, and teeth of very small animals still remains to be determined.

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## No. XXXIII.—Geological Observations in the Parish of East Kilbride, Lanarkshire. By Andrew Patton, Cor. Mem. With a List of Fossils, compiled by James Coutts. With Two Sections [Plate XIII].

[Read 14th February, 1884.]

The slatyband ironstone, with its accompanying strata, is now the acknowledged base of the true coal measures, as given by Mr. Ralph Moore, Government inspector, in his chart of the probable position of the minerals in the various coalfields of Scotland, where he states that it lies between 400 and 500 fathoms above the Crossbasket

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ironstone series. As it has not, however, been found in any bore, pit, quarry, or ravine, in the district, we must look, I infer, for the position of the Kilbride strata in some lower horizon than that of the true Coal Measures, viz., in that of the lower coals and ironstones of the limestone series.

From all my investigations, now continued over many years, I have come to the conclusion that our groups of stratified rocks obtain their greatest altitude at or near the pit known as Calderwood Colliery, on the estate of the same name, the coal there being, I believe, the equivalent of that now wrought at Crutherland, and formerly worked at Capelrig, Blacklaw, Murray, Whitehills, East Netherton, Torrance, Edge, Newhouse Mill, and Calderside. The seams at all these places are thin and of indifferent quality, but they may be said to map out the area of the East Kilbride coalfield, and to represent that of the Possil and Govan strata near Glasgow, and the coals and ironstones of the limestone series in the Carluke coalfield.

To indicate the strata overlying this coalfield I cannot do better than refer to the journal of the pit put down by Messrs. John Brown & Co., in Calder Glen or Mauchlinhole Farm, and worked by them for some years. It is as follows:—

| | | Fm. | Ft. | In. | |
|---|---|---|---|---|---|
| | Surface, | 1 | 3 | 6 | |
| | Freestone soft, | 1 | 5 | 0 | |
| No. 1.— | Soft coal, | 0 | 0 | 4 | |
| | Dark shale, | 0 | 3 | 0 | |
| | Blackband ironstone, | 0 | 0 | 2 | Contain a little oil. |
| | Black shale, | 0 | 4 | 0 | |
| | Dark shale, soft, | 0 | 1 | 0 | |
| | Clayband ironstone, | 0 | 0 | 9 | |
| | Grey sandstone, | 0 | 0 | 5 | |
| No. 2.— | Soft coal, | 0 | 0 | 2½ | |
| | Dark faiks, | 0 | 0 | 4 | |
| | Freestone, | 1 | 1 | 0 | |
| | Dark shale, | 1 | 1 | 0 | |
| | Dark faiky shale, | 0 | 2 | 6 | |
| | Kingle, | 0 | 1 | 1 | Very hard silicious sandstone resembling quartzite. |
| | Dark faiks, | 0 | 3 | 1 | |
| | Dark shale, | 0 | 4 | 3 | |
| | Clayband ironstone, | 0 | 0 | 4 | Contains *Lingula* (good). |
| | Dark shale, | 0 | 2 | 2 | Contains a little oil. |

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| | Fm. | Ft. | In. | |
|---|---|---|---|---|
| Clayband ironstone, | 0 | 0 | 3 | |
| Dark shale with ironstone balls, | 1 | 2 | 9 | |
| Clayband ironstone, | 0 | 0 | 7 | Sample analysed contains 30 per cent. of iron. |
| Dark shale, | 0 | 4 | 11 | |
| Clayband ironstone, | 0 | 0 | 2 | |
| Soft shale, | 0 | 0 | 3 | |
| Black sandstone, | 0 | 0 | 6 | Hard, burns in the fire with a bright flame but does not decrease in bulk. |
| Grey faiks, | 0 | 0 | 8 | |
| Soft shale, | 0 | 0 | 2 | |
| Dark shale, | 0 | 0 | 2 | |
| Impure ironstone, | 0 | 1 | 0 | Hard, with yellowish streaks, burns in the fire. |
| Grey faiks, | 0 | 0 | 6 | |
| Dark shale, | 0 | 0 | 6 | |
| Grey faiks, | 0 | 1 | 4 | |
| Grey freestone, | 0 | 0 | 10 | |
| Dark shale, | 0 | 0 | 6 | |
| Freestone, | 0 | 0 | 6 | |
| Sandy faiks, | 0 | 0 | 7 | |
| Hard white freestone, | 0 | 3 | 1 | |
| Sandy faiks, | 0 | 1 | 0 | |
| Dark shale, | 0 | 2 | 0 | |
| Grey faiks, | 0 | 0 | 3 | |
| No. 3.—Coal, | 0 | 0 | 1 | |
| Soft white freestone, | 0 | 3 | 2 | |
| Do. do. with black partings, | 0 | 2 | 4 | |
| Dark shale, | 0 | 3 | 6 | |
| No. 4.—Coal, | 0 | 0 | 1 | |
| Fireclay, | 0 | 0 | 10 | |
| Freestone, | 1 | 1 | 0 | |
| Sandy shale, | 0 | 0 | 9 | |
| Freestone, | 0 | 2 | 6 | |
| Dark shale, | 1 | 1 | 7 | |
| Fireclay, | 0 | 0 | 6 | |
| Sandy faiks, | 0 | 2 | 5 | |
| Dark shale, with ironstone balls, | 0 | 4 | 4 | |
| No. 5.—Coal, | 0 | 1 | 8 | House coal of Crutherland. |
| Fireclay, | 0 | 0 | 7 | |
| Fireclay, with nodules, | 0 | 3 | 1 | |
| No. 6.—Coal, | 0 | 2 | 9 | Joint Coal of Crutherland mixed with shale. |

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| | Fm. | Ft. | In. |
|---|---|---|---|
| Soft white sandstone plies, | 0 | 4 | 3 |
| Hard white sandstone, | 1 | 3 | 5 |
| Hard white kingle, | 0 | 2 | 11 |
| Dark shale, | 0 | 2 | 9 |
| No. 7.—Coal mixed with sand, | 0 | 1 | 3 |
| Grey freestone, | 0 | 3 | 6 |
| Dark sandy shale, | 0 | 2 | 3 |
| No. 8.—Coal, | 0 | 0 | 10 |
| Fireclay, | 0 | 0 | 4 |
| Rock plies, | 0 | 1 | 8 |
| | 26 | 2 | 11½ |

In the journal of the bore put down in East Netherton farm by J. Wood, in 1856, there are four seams of coal given, from one inch to nine inches, and although the strata do not correlate with those of the journal of Calderwood Colliery, I have no doubt that they are the same seam of coal.

Believing that I am correct in placing No. 8 coal in the position of Calderside Coal, I now give details of the strata as they are seen in Hart's Burn, a small streamlet falling into Calder Water, a little way below the Black Linn.

| | Fm. | Ft. | In. | |
|---|---|---|---|---|
| Strata, | 4 | 4 | 0 | |
| Dark shale, | 1 | 3 | 0 | |
| Freestone, | 2 | 5 | 0 | |
| Coal, | 0 | 0 | 7 | |
| Freestone, | 5 | 4 | 0 | |
| Sandy shale, | 0 | 5 | 0 | |
| Shales, faiks, and thick plies of freestone, | 2 | 1 | 0 | |
| Sandy shale, | 0 | 5 | 3 | |
| Clay ironstone, | 0 | 0 | 1½ | |
| Dark shale, | 1 | 0 | 2 | |
| Clay ironstone, | 0 | 0 | 3 | |
| Dark shale, | 0 | 5 | 7 | Good sections of all these last nine beds are seen opposite Calderside Holm, below the old kilns on the left bank of the Calder Water. |
| Clay ironstone, | 0 | 0 | 3 | |
| Dark shale, | 1 | 0 | 7 | |
| Clay ironstone, | 0 | 0 | 3½ | |
| Dark shale, | 0 | 5 | 4½ | |
| Clay ironstone, | 0 | 0 | 4 | |
| Dark shale, | 1 | 2 | 7 | |
| Clay ironstone, | 0 | 0 | 4 | |
| Dark shale, | 2 | 5 | 6½ | |
| Roman cement, | 0 | 0 | 11 | |
| Shale, | 1 | 1 | 0 | |

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| | Fm. | Ft. | In. |
|---|---|---|---|
| Limestone, . . . . | 0 | 1 | 4 |
| Shale and fireclay, . . . | 1 | 5 | 0 |
| Limestone, . . . . | 0 | 1 | 6 |
| Fossiliferous shale, . . . | 0 | 2 | 6 |
| Limestone, . . . . | 0 | 4 | 0 |
| | 31 | 5 | 6 |

The above-mentioned Roman cement is the first post limestone of the Calderwood series given by the officers of the Geological Survey as the equivalents of the calmy limestone which overlies the first Kingshaw bed of Carluke. Assuming that the Survey officers are correct in regard to our position, we might have expected to find the Lesmahagow gas coal in the district, as it is found about 30 fathoms above the calmy limestone, and in the Auchenheath district about 28 fathoms above the *Lingula* or calmy limestone. We have detailed above 58 fathoms of strata (including the limestones), which have almost all been seen with the eye, and nothing at all corresponding to the Lesmahagow gas coal has been found. The above-mentioned limestones have been worked at Calderside, Binnie's Holm, Brankumhall, Capelrig, Black Braes (where they are found in close proximity to the igneous rocks), Limekilns, Stuartfield, Kirktonholm, and Burnbrae. In this latter place the main post is found to be absent, its place being taken by 10 feet of dark shale, the first two feet of which contain fossils similar to those found in the upper portions of the fossiliferous shale, which occurs between the second post and the main post of limestone. Under the above 10 feet of shale is found a coarse gritty limestone one foot thick, and at East Milltown (where the dark shale appears to attain a greater thickness than at Burnbrae), at Duncanrigg, and Headhouse, Mossneuk, and Newlands, and they are also seen in the Gill Burn at Jackton.

In Ure's "History of Rutherglen and East Kilbride" will be found a detailed account of the various minerals found in the parish. He gives the cement-stone as a coarse ironstone. On examining the cement ironstones and shales exposed at the above place I found fossils similar to those got at Limekilns and elsewhere. The limestones have been wrought at Lickprivick and Langlands. They are also said to have been worked on the lands of Allerton, on the banks of the River Cart, but I have never seen any indications of them when visiting that locality. A thin bed of limestone charged



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with *Lingula* is seen in the bed of the Cart, and on its west bank, between the site of the old bridge and Craigenfeoch. It will be seen on consulting the Geological Survey map of this district that we have several square miles of the Calderwood series of limestone in East Kilbride.

We have now arrived at the strata overlying the Crossbasket ironstones, and I shall give as a type of the district the journal of a pit put down about thirty years ago (in 1853) by Mr. William Dixon, on the lands of Park, the property of Mr. William Jackson.

| | | Fm. | Ft. | In. |
|---|---|---|---|---|
| | Sandy shale, | 0 | 1 | 6 |
| | Rock and rock plies, | 4 | 0 | 0 |
| | Rock, generally white, | 10 | 0 | 0 |
| | Faiks and shales, | 3 | 3 | 6 |
| | Dark shale, | 2 | 0 | 6 |
| | Coally shale, | 0 | 1 | 0 |
| | Horny band, | 0 | 0 | 6 |
| | Coally shale, | 0 | 0 | 8 |
| | Dark shale, | 0 | 2 | 6 |
| No. 1. | Ironstone, | 0 | 0 | 6 |
| | Dark shale, | 1 | 0 | 0 |
| No. 2. | Ironstone, | 0 | 0 | 9 |
| | Shale and balls, | 2 | 0 | 0 |
| | Ironstone balls, | 0 | 0 | 4 |
| | Dark shale, | 0 | 2 | 6 |
| No. 3. | Ironstone, | 0 | 0 | 9 |
| | "Sump" dark shale, | 1 | 0 | 0 |
| | Strata, | 6 | 0 | 0 |
| | *Foul limestone, | 0 | 4 | 0 |
| | Hard freestone rock, | 1 | 4 | 0 |
| | Dark shale, | 1 | 5 | 0 |
| | Coal, | 0 | 0 | 10 |
| | Light shale, | 1 | 2 | 0 |
| | Limestone, | 0 | 1 | 0 |
| | Light shale, | 0 | 1 | 4 |
| | Rock plies, | 0 | 2 | 4 |
| | Dark shale with iron balls, | 0 | 4 | 0 |
| | Rock plies, | 0 | 2 | 10 |
| | Dark shale, | 0 | 1 | 0 |

* This limestone bed is exposed at the fault nearly opposite Basket Farm, down to what is known as the "Miner's Plank." The ironstones exposed there are locally known as the "whitestone." They were wrought a number of years ago by Messrs. Colin Dunlop & Co. for the Clyde Ironworks.

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| | Fm. | Ft. | In. |
|---|---|---|---|
| Clay ironstone, | 0 | 0 | 6 |
| Dark shale, | 0 | 5 | 0 |
| Clay ironstone, | 0 | 0 | 4 |
| Dark shale, | 0 | 3 | 0 |
| Clay ironstone, | 0 | 0 | 4 |
| Dark shale, | 0 | 2 | 6 |
| Dark shale, | 0 | 0 | 4 |
| Dark shale with ironstone balls, | 0 | 4 | 0 |
| Coal, | 0 | 0 | 4 |
| Light sandy shale, | 1 | 4 | 8 |
| Sandstone, hard, | 0 | 2 | 4 |
| Light sandy shale, | 0 | 4 | 0 |
| Limestone, | 0 | 2 | 0 |
| Light sandy shale, | 3 | 2 | 0 |
| Sandstone, hard, | 0 | 1 | 8 |
| Light sandy shale, | 0 | 1 | 6 |
| | 50 | 5 | 10 |

We have thus above detailed 108 fathoms of strata which can be, or have been, seen, carrying us down to the "Miner's Plank," where it appears to me that a reversal of dip takes place, which causes the strike of the strata to run nearly parallel with the Calder Water, and allows the "whitestone" ironstones to be worked on the west bank of the river for a considerable distance, until thick-bedded white sandstones seem to take their place a short distance above Crossbasket Bridge. The same ironstones can be seen in section between "Lady's Linn" and the "Miner's Plank," along the banks of the Calder Water. They are also to be seen on the banks of the Kittoch Burn, between Springbank Bridge and Arrotshole Farm, though I am of the opinion that only the lower portions of the series of the Crossbasket ironstones are there exposed. I shall give in detail the section as seen:—

| | Fm. | Ft. | In. | |
|---|---|---|---|---|
| Dark brown sandstone, | 0 | 4 | 4 | |
| Dark shale with rock plies, | 4 | 1 | 0 | |
| Dark shale, | 0 | 3 | 0 | |
| Dark coally shale, | 0 | 0 | 6 | Contains plant and fish remains. |
| Soft fireclay, | 0 | 0 | 3 | |
| Dark shale, | 0 | 1 | 0 | Contains plant remains. |
| Clay ironstone, | 0 | 0 | 2 | |
| Soft shale, | 0 | 0 | 3 | |
| Dark coally shale, | 0 | 0 | 6 | Plant and fish remains. |

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| | Fm. | Ft. | In. | |
|---|---|---|---|---|
| Clay ironstone, . . . . | 0 | 0 | 3 | |
| Dark coally shale, . . . | 0 | 0 | 2 | |
| Clay ironstone, . . . . | 0 | 0 | 3 | |
| Dark shale, . . . . | 0 | 0 | 8 | |
| Clay ironstone, . . . . | 0 | 0 | 1 | |
| Dark shale, . . . . | 0 | 2 | 0 | |
| Clay ironstone, . . . . | 0 | 0 | 3 | |
| Dark shale, . . . . | 1 | 0 | 0 | |
| Limestone, . . . . | 0 | 1 | 8 | Encrinital. |
| Volcanic ash, . . . . | 0 | 2 | 8 | |
| Dark shale, . . . . | 0 | 5 | 0 | Plant and fish remains. |
| Black coally shale, . . . | 0 | 0 | 8 | |
| Clay ironstone, . . . . | 0 | 0 | 4 | |
| Dark shale, . . . . | 0 | 1 | 0 | |
| Ironstone, . . . . | 0 | 0 | 5 | |
| Dark shale, . . . . | 2 | 0 | 0 | |
| Coarse faiky lime, . . . | 0 | 0 | 3 | |
| Fine faiky lime, . . . | 0 | 0 | 8 | |
| Coarse faiky lime, . . . | 0 | 0 | 6 | |
| Dark shale, . . . . | 0 | 3 | 0 | |
| Volcanic ash, . . . . | | | | |
| | 11 | 0 | 10 | |

From the journal of a bore put down on the Kirktonholm estate, in a field north of Threshold, by John Barrie in 1842, we find, beginning at the bottom of the Calderwood limestone series, detailed strata as follows :—

| | Fm. | Ft. | In. |
|---|---|---|---|
| Faiks and blaes, . . . | 0 | 2 | 4 |
| White and dark freestone, . | 6 | 2 | 6 |
| Faiks and blaes, . . . | 10 | 2 | 0 |
| Hard faiky band, . . . | 0 | 0 | 8 |
| Faiks and blaes, . . . | 3 | 4 | 8 |
| *Limestone, . . . . | 0 | 1 | 6 |
| Blaes, . . . . . | 0 | 0 | 4 |
| Faiky blaes, . . . . | 0 | 3 | 10 |
| Blaes, . . . . . | 0 | 1 | 4 |
| Faiky blaes, . . . . | 2 | 0 | 8 |

* Referring back to the journal of the Blantyre Park pit we find this limestone in the position of No. 1 ironstone, at least if we take distance in proof thereof. But we find nothing corresponding to No. 2 ironstone, and, supposing this portion to correlate with the Crossbasket ironstone, it should be No. 3. If so, all through the district in which the Calderwood ironstone is exposed there must be a vast field of clay ironstone as yet untouched.

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| | Fm. | Ft. | In. | |
|---|---|---|---|---|
| Clay ironstone, | 0 | 0 | 6 | |
| Faiky blaes, | 0 | 4 | 8 | |
| Faiks and blaes, | 3 | 2 | 7 | |
| Blaes, | 0 | 5 | 6 | |
| Clay ironstone, | 0 | 0 | 5 | |
| Ironstone, | 0 | 0 | 3 | |
| Blaes, | 0 | 2 | 7 | |
| Hard limestone, | 0 | 0 | 8 | Possibly this is the Hairmyres limestone. |
| Soft limestone, | 0 | 1 | 4 | |
| Hard limestone, | 0 | 4 | 1 | |
| Faiks and blaes, | 0 | 2 | 8 | |
| Fireclay, | 0 | 3 | 7 | |
| White rock band, | 0 | 0 | 3 | |
| Fireclay, | 0 | 1 | 10 | |
| White rock, | 0 | 5 | 3 | |
| Blaes, | 0 | 4 | 6 | |
| | 34 | 0 | 6 | |

Next in order we have the Hairmyres limestone capped by sandstones, shales, and ironstones, of which we know but little until we arrive at the limestone itself, when we find it capped by limey faiks, the hard portions of which are almost entirely composed of encrinital remains, while the soft portions or beds are the matrix in which are found the beautiful polyzoa, described by Professor Young and Mr. John Young, of the University of Glasgow. The limestone averages about 2 feet 4 inches in thickness. By the kindness of Mr. Peter Forrest I am enabled to give the journal of the bore put down by Mr. Thomson in the lands of Hairmyres from the bottom of the limestone to the Braehead limestone:—

| | Fm. | Ft. | In. | |
|---|---|---|---|---|
| Lime faiks, | 0 | 3 | 9 | As seen in old quarry. |
| Limestone, | 0 | 2 | 4 | |

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| | | | | |
|---|---|---|---|---|
| Lime sole, | 0 | 0 | 9 | |
| Sandstone, | 0 | 3 | 6 | |
| Foul coal, | 0 | 0 | 2 | |
| Blue faiks, | 5 | 0 | 0 | |
| Dark blaes with iron balls, | 4 | 3 | 0 | |
| Limestone, | 0 | 3 | 2 | Hosie limestone, according to James Neilson, Glasgow. |
| Light fireclay, | 1 | 2 | 0 | |
| Limestone, | 0 | 2 | 4 | |
| Blue blaes, | 0 | 2 | 0 | |

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| | Fm. | Ft. | In. |
|---|---|---|---|
| Limestone, | 0 | 5 | 0 |
| Fireclay parting, | 0 | 0 | 2 |
| Limestone, | 0 | 5 | 9 |
| Lime faiks, | 0 | 0 | 6 |
| Blue limey faiks, | 0 | 1 | 0 |
| | 15 | 5 | 5 |

These limestones are wrought at Braehead, Thorntonhall, Philiphall, and Peel Park quarries, and at Drips. Mr. Kirkwood is at present putting out large quantities for the furnaces (1882). I find nothing to correlate with these limestones, unless from a bore on West Netherton Farm, which was put down by Mr. J. Wood in 1856, where we find the following :—

| | Fm. | Ft. | In. | |
|---|---|---|---|---|
| Strata, | 10 | 4 | 2 | The equivalent of the Hairmyres limestone as given above. |
| Lime, | 0 | 2 | 0 | |
| Strata, | 11 | 1 | 1 | |
| Limestone, | 0 | 3 | 0 | The equivalent of the Hosie limestone, according to James Neilson. |
| Fireclay, | 0 | 3 | 6 | |
| Black shale, | 0 | 4 | 0 | |
| Fireclay, | 0 | 3 | 6 | |
| Black shale, | 0 | 4 | 0 | |
| Limestone, | 0 | 1 | 9 | |
| Shale, | 0 | 0 | 3 | |
| Lime, | 0 | 2 | 6 | |
| Dark faiks, | 0 | 1 | 0 | |
| Lime, | 1 | 0 | 6 | |
| Grey faiks, | 0 | 1 | 0 | |
| Strata, | 10 | 3 | 10 | |
| Limestone plies, | 0 | 4 | 0 | The equivalent of the Crosshouse limestone.* |
| Limestone, | 2 | 0 | 0 | |
| Hard faiks, | 1 | 4 | 0 | |
| | 41 | 0 | 7 | |

The lowest of these above-mentioned limestones I believe to be the equivalents of the beds which are worked at Crosshouse and

* The Officers of the Geological Survey give the position of Braehead and Thornton as the equivalent of Crosshouse and South Shields. There is no evidence to the contrary with the exception of this bore, and we know that borers are not infallible.

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Shields Farms, and I would expect to find them underlying the Busby limestones at Braehead, unless the volcanic ash takes their place, as seen in the railway cutting opposite Thorntonhall, and at Peel Park on the other side.

Coming back to Calder Glen; for some time I was of opinion that the limestone, exposed in the banks of the Calder water, opposite Basket Farm, might be the equivalent of the Hairmyres and Busby series, but dwarfed, the first or four-feet seam representing Hairmyres; it is a foul limestone, and much corroded where exposed. When visiting the locality, however, on later occasions I have seen so little to correlate with the Hairmyres and Braehead series, that I have given up the idea altogether of being able to work out the identity of the two seams. In bore No. 1, put down in field 86 of Calderwood estate plan, west of Nethermain's farm, by John Wood, in 1838, we find detailed in succession a number of thin beds of lime and black sandstone, and these, not being seen in the banks of the Calder Water, I believe underlie any of the beds detailed.

Near the bottom of the bore, which is carried to a depth of 40 fathoms 4 feet, is found a limestone, 4 feet in thickness, which, according to Wm. Paterson's (late forester on the estate) account of the bore, was believed by Mr. Wood to represent the foul limestone represented above.

North by east of bore No. 1, in field 91 of the Calderwood estate plan, in a bore sunk to a total depth of 21 fathoms 8 feet 11 inches, we find sandstones, mostly white, about 30 feet thick, and underlying them two beds of limestone—the one 14 feet 8 inches, and the other 20 feet 8 inches thick. The journal is as follows:—

| | Fm. | Ft. | In. |
|---|---|---|---|
| Surface, | 4 | 1 | 7 |
| Shale, | 1 | 3 | 2 |
| Sandy fireclay, | 0 | 4 | 6 |
| Hard white sandstone, | 2 | 4 | 7 |
| Shale, | 0 | 0 | 8 |
| White sandstone, | 0 | 0 | 10 |
| Hard faiks, | 0 | 2 | 6 |
| Faiks, | 0 | 2 | 1 |
| Kingle, | 0 | 1 | 6 |
| Faiks, | 0 | 1 | 3 |
| Kingle, | 0 | 0 | 10 |
| Sandy fireclay, | 0 | 5 | 10 |
| Green sandstone, | 2 | 0 | 6 |

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| | Fm. | Ft. | In. |
|---|---|---|---|
| Coarse limestone, mixed with whin, | 1 | 1 | 0 |
| Hard limestone, | 1 | 1 | 8 |
| Faiks, | 0 | 4 | 9 |
| Red sandstone, | 0 | 5 | 0 |
| Hard limestone, | 3 | 2 | 8 |
| Faiks, | 0 | 1 | 0 |
| | 21 | 3 | 11 |

In the bore opposite (Stony Meadow) Old Toll Holm, we find again underlying the white sandstones, limestones 22 feet and limestone 3 feet thick. A pit was put down here by Mr. James Brownlie, East Kilbride, and the lime was found to be of very inferior quality. My own opinion is that these are nothing more than the trappean ash-beds, seen in the cuttings of the Blantyre and East Kilbride Railway. The following is the journal referred to :—

| | Fm. | Ft. | In. |
|---|---|---|---|
| Surface, | 0 | 3 | 5 |
| Sandstone, | 0 | 1 | 2 |
| Faiks, | 0 | 2 | 6 |
| Hard sandstone, | 0 | 1 | 5 |
| Soft white sandstone, | 0 | 3 | 4 |
| Blaes, | 0 | 1 | 1 |
| Soft white sandstone, | 1 | 1 | 10 |
| Coarse limestone, | 0 | 4 | 0 |
| Hard limestone, | 3 | 0 | 1 |
| Red sandstone, | 0 | 4 | 0 |
| Hard limestone, | 0 | 3 | 0 |
| | 8 | 1 | 10 |

From what we have seen we might infer that on some future occasion the Hairmyres and Braehead limestones might be found in the strata unexplored between the bore in field 86 and that in field 91 of Calderwood estate plan. I have, however, given in the previous remarks the extent of the observations which I have been able to make among the higher strata of the East Kilbride district.

A number of dislocations or faults in the strata are seen in the banks of the Calder Water, but there are only two which appear to be of any magnitude. The one is above the "Miner's Plank," opposite Basket Farm, where a mine was driven from the level of the water, cutting the No. 3 ironstone at a distance of about 400 yards, and showing the throw to be about 25 fathoms, bringing

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the "Whitestone" series up to the level, or nearly so, of No. 3 upper series. The second is at the Black Linn, where the 7-inch coal is seen a few feet above the level of the water, showing the throw to be about 14 fathoms. Both these throws dip to the south, running south-east and north-west, and are probably offshoots from the great Eddlewood fault, which cuts off the upper coal measures a little to the south of Blantyre. The natural rise of the strata seems to be to the south-west, but there must be a great many displacements between the Calder Water and the Gill Burn at Jackton, where the Calderwood series comes to the surface for the last time in the parish.

Several post-tertiary or old river channels have been met with during mining operations in the district. The first we hear of was met with in the working of the Startuphall or March coal, which was cut through by Walter Locke, Maxweltown, East Kilbride. He states that he lost sight of the coal, and in its place he met with stones, earth, and sand. Knowing the coal to be on the opposite side of the field, he went on for sixty feet, when he again came upon the coal at the same level as that at which he had lost it.

The next is nearer the Calder Water, a portion of it being exposed at the lower end of the Blue Brae, opposite Calderside Holme, and supposed by many to be a bank of denudation. It was found by Messrs. John Brown & Co., in mining the Roman cement in 1858 or 1859, and it was ascertained by previous boring that the cement was but a short distance to the west of it. James Torley, who took a contract to drive a mine to the cement on the opposite side, cut 25 fathoms. He described to me the cutting as consisting of *debris* such as is seen in the bank at the foot of the Blue Brae. One stone met with took a whole week to cut through. The mine seems to have been driven at the bottom of the water-course; as Torley said, they had the first post of limestone for a pavement the whole road, but through some mismanagement they went wrong, and the work was abandoned. In working other mines further up the water, the same *debris* was come upon in several places, so that I think there is no doubt that this is an old river course, probably belonging to pre-glacial times.

Again, in the workings of the Calderwood Colliery, similar appearances were come upon in the cuttings at the north-east portion of the pit. In every case the want was found, first in "brushing" the roadway, showing that the sloping banks were there, the depth

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from the surface being 120 feet. We never attempted to carry any of the roads into it, but the *debris* exposed was similar to that found in the cement mines on Calder Water.

In the course of working the cement mines on Kirktonholm estate, another old river channel was discovered. It was about 100 feet wide, and was filled up with boulder clay. On each side of the old channel the shale rose in sloping banks, just similar to those of any river banks at the present day. The cement-stone being the bed of the old river, was very often broken up, and was piled up at some points, until the workmen would fancy that they had reached three or four seams in place of one, but in such cases there was always a want at the back of them. The depth, from the surface, ranged from 20 to 60 feet. The fact that this channel was filled with Boulder-clay points to the conclusion that a river existed in this place prior to the ice age. The appearances met with elsewhere in the same neighbourhood, when wells were being put down, and cement was being bored for in the Glebe quarries, are quite different, the Boulder-clay in such cases being all denuded away, and its place being taken by gravel, peat, and sand, fragments of coal and ironstone being frequently mixed up in the mass.

The fossils of the East Kilbride district are numerous and varied, and have been long observed, the earliest recorder of their occurrence being the pioneer of western Scottish palæontology, the Rev. David Ure, of East Kilbride, who in his history of the parish has given figures of many of the leading forms.

I shall now proceed to give a list of those fossils met with from time to time during my explorations of the district, principally compiled, with the expenditure of much time and trouble, by my friend Mr. James Coutts, who has already been the means of bringing a number of the rarer and more interesting forms in my collection under the notice of the members of the Society.

It has been thought best to indicate the localities where the fossils were found, as being more convenient for the collector. At some of these places, especially in the Calderwood group, as Limekilns Quarry, Capelrig Quarry, and Newfield Quarry and Mines, different beds were worked at various times, and, consequently, the fossils were from different horizons. The differences are not, however, great geologically, as the fossils are all from strata connected with the Calderwood limestone and the Calderwood cement-stone,

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the position of the latter being 25 feet or so the higher of the two. The fossils from Breusterland mines, the Glebe quarries, Kirktonholm mines, and Newfield cement-stone pit, are all from shale either overlying the cement-stone two to three feet, or underlying it about one foot and a half, or from the cement-stone itself. The fossils from the South Shields Quarry are from the shale overlying, or interbedded with, the limestone; the fossils from Braehead and Thornton quarries are from the limestone, and the shales above it. These limestones and shales are the equivalents of the Hurlet and Campsie main limestone. The Hairmyres limestone and shales are separated from the Braehead main limestone by 72 feet of strata, so there is no doubt of its belonging to the lower limestone group.

It ought further to be stated that the fossils in my collection were largely named by Mr. Robert Etheridge, jun., F.G.S., of the Natural History Department, British Museum, and that in the preparation of the list by Mr. Coutts assistance has been afforded in their special departments by Dr. R. H. Traquair, F.R.S., of the Science and Art Museum, Edinburgh; by Mr. B. N. Peach, F.G.S., of the Geological Survey of Scotland; by Mr. James Bennie, Fossil Collector to the Survey; by Mr. Robert Kidston, F.G.S., Stirling; and specially to Mr. John Young, F.G.S., of the Hunterian Museum, University of Glasgow. To all these gentlemen, therefore, I am much indebted, and I beg to thank them accordingly.

NOTE.—It should be understood that the following list of fossils makes no pretensions to be considered exhaustive. No doubt a few species not in my collection, although noted in other lists, might be added, but these I have not been able to verify. It is probable that the number of species will be increased from time to time as the strata of the district becomes more thoroughly examined and the organisms more carefully determined.

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## LIST OF FOSSILS FOUND IN THE LOWER LIMESTONE SERIES OF EAST KILBRIDE, LANARKSHIRE.

| SPECIES. | LOWER LIMESTONE SERIES. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
| | Limekilns Quarry. | Breusterland Mines. | Glebe Quarry. | Kirktonholm Mines. | Burnbrae Mine. | Cayelrig Quarry. | Calderside Mines. | Newfield Limestone Pit. | Hairmyres Quarries. | Thornton Quarries. | Brachead Quarry. | Crosshouse Quarry. | South Shields Quarry. |
| **FILICES.** | | | | | | | | | | | | | |
| *Adiantites Machaneki*, Stur. | x | x | x | x | x | | | | | | | | |
| *Archæopteris Tschermaki*, Stur. | x | x | x | x | x | | | | | | | | |
| ,, sp. (allied to *A. Dawsoni*, Stur). | x | | | | | | | | | | | | |
| *Calymmatotheca*, sp. | x | | | | | | | | | | | | |
| *Cyclopteris nana*, Eichwald. | x | x | x | x | x | | | | | | | | |
| *Neuropteris antecedens*, Stur. | x | | | | | | | | | | | | |
| *Rhacopteris transitionis*, Stur. | x | x | x | x | x | | | | | | | | |
| ,, *Lindsæformis*, Bunbury, sp. | x | x | x | x | x | | | | | | | | |
| ,, *petiolata* (?), Göpp, sp. | x | | | | | | | | | | | | |
| *Sphenopteris Ettingshauseni*, Feistm. | x | x | x | x | | | | | | | | | |
| ,, *Gersdorfii*, Göpp, sp. | | | x | | | | | | | | | | |
| ,, *Haueri*, Stur. | | | x | | | | | | | | | | |
| ,, sp. | | | x | | | | | | | | | | |
| **EQUISETACEÆ.** | | | | | | | | | | | | | |
| *Asterocalamites scrobiculatus*, Schlotheim, sp. | x | | x | x | | | x | | | | | | |
| **LYCOPODIACEÆ.** | | | | | | | | | | | | | |
| *Lepidodendron Harcourtii*, Witham. (stem showing structure). | x | | | | | | | | | | | | |
| ,, *Rhodeanum*, Sternb. | x | x | x | x | x | | | | | | | | |
| ,, *Veltheimianum*, Sternb. | x | x | x | x | x | | | | | | | | |
| *Lepidophloios*, sp. | x | | | | | | | | | | | | |
| *Lepidophyllum* (and cone scales). | x | | | | | | | | | | | | |
| *Lepidostrobus variabilis*, L. and H. | x | x | x | x | | | x | | | | | | |
| *Stigmaria ficoides*, Brong. | x | x | x | x | | | x | | | | | | |
| **FRUIT (of uncertain affinity).** | | | | | | | | | | | | | |
| *Trigonocarpum Gloagianum*, J. Yng. | x | | x | x | | | x | | | | | | |

NOTE.—This list cancels all previous lists of Fossil Plants from the Cement Limestones of East Kilbride. The original specimens have been carefully re-examined, and many of them have been found to have been inaccurately determined.—R. Kidston, F.G.S., Oct., 1884.

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| SPECIES. | LOWER LIMESTONE SERIES. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
| | Limekilns Quarry. | Breusterland Mines. | Glebe Quarry. | Kirktonholm Mines. | Burnbrae Mine. | Capelrig Quarry. | Calderside Mines. | Newfield Limestone Pit. | Hairmyres Quarries. | Thornton Quarries. | Braehead Quarry. | Crosshouse Quarry. | South Shields Quarry. |
| FORAMINIFERA. | | | | | | | | | | | | | |
| *Archæodiscus Karreri*, Brady. | | | | | | | | x | | | | | x |
| *Endothyra ammonoides*, Brady. | x | | | | x | x | x | x | x | | | | |
| ,, *Bowmanni*, Phill. | | | | | | x | | x | | | | | |
| ,, *globulus*, D'Eichw. | x | | | | x | x | x | x | | | | | |
| ,, *ornata*, Brady. | | | | | | x | | | | | | | |
| ,, *radiata*, Brady. | | | | | | x | | | x | | | | |
| *Stacheia acervalis*, Brady. | x | | | | | x | | x | x | | | | x |
| ,, *congesta*, Brady. | | | | | | x | | | | | | | |
| ,, *fusiformis*, Brady. | | | | | | x | | | x | | | | |
| ,, *polytremoides*, Brady. | | | | | | | | | x | | | | |
| ,, *pupoides*, Brady. | | | | | | x | | | x | | | | |
| *Trochammina anceps*, Brady. | | | | | | x | | | | | | | |
| ,, *annularis*, Brady. | | | | | | x | | | | | | | |
| ,, *incerta*, Brady. | x | | | | x | x | x | x | | | | | |
| *Valvulina decurrens*, Brady. | x | | | | x | x | | x | | | | | x |
| ,, *palæotrochus*, Ehrenb. | x | | | | | x | | x | | | | | x |
| ,, *plicata*, Brady. | x | | | | | x | x | x | | | | | |
| SPONGIDÆ. | | | | | | | | | | | | | |
| *Holasterella Youngi*, Hinde. | | | | | | | | | x | | | | |
| HYDROZOA. | | | | | | | | | | | | | |
| *Palæocoryne* (?) *radiatum*, D. & J. | | | | | | x | | | x | | | | |
| ,, (?) *Scoticum*, D. & J. | | | | | | x | | | x | | | | |
| ACTINOZOA. | | | | | | | | | | | | | |
| *Amplexus Henslowi*, M. Edw. | | | | | | | | | | | | x | x |
| ,, *spinosus*, De Kon. | | | | | | | | | | | | x | x |
| *Aulophyllum fungites*, M. Edw. | | | | | | | | | | | | x | x |
| *Chætetes septosus*, Flem. | | | | | | | | | | | x | x | x |
| *Clisiophyllum turbinatum*, M'Coy. | | | | | | | | | | | | x | x |
| *Cyathaxonia cornu*, Mich. | | | | | | | | | | | | | x |
| *Cyathophyllum Stutchburyi*, M. Edw. | | | | | | | | | | | | x | x |
| *Fistulipora minor*, M'Coy. | | | | | | | | | | | | | |
| *Heterotrypa tumida*, Phill. | | | | | | | | | | | | | |
| ,, ,, var. *miliaria*, Nich. | | | | | | x | | x | | | | | |
| *Lithodendron fasciculatum*, Flem. | | | | | | x | x | | | | | | |
| ,, *junceum*, Flem. | | | | | | | | | | | x | | |
| *Lophophyllum reticulatum*, Thoms. and Nich. | | | | | | | | | | | | | x |
| ,, *Scoticum*, Thoms. and Nich. | | | | | | | | | | | | | x |
| *Palæacis cyclostoma*, Phill. | | | | | | | x | | | | x | | |
| *Tabulipora Urii*, Flem. | | | | | | x | x | x | | | | | |
| *Zaphrentis Enniskilleni*, M. Edw. | x | | | x | | | x | x | | | | | x |
| ,, *Griffithi*. M. Edw. | | | | | | | | | | | x | | |
| ,, *Phillipsi*, M. Edw. | | | | | | x | x | | | x | | x | |

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| SPECIES. | LOWER LIMESTONE SERIES. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
| | Limekilns Quarry. | Breusterland Mines. | Glebe Quarry. | Kirktonholm Mines. | Burnbrae Mine. | Capelrig Quarry. | Caldersido Mines. | Newfield Limestone Pit. | Hairmyres Quarries. | Thornton Quarries. | Braehead Quarry. | Crosshouse Quarry. | South Shields Quarry. |
| ECHINODERMATA (ECHINOIDEA). | | | | | | | | | | | | | |
| *Archæocidaris Urei*, Flem. | x | x | x | x | x | x | | x | x | x | x | x | x |
| ,, *Scotica*, J. Young. | x | | | | | | | | | | | | |
| ECHINODERMATA (CRINOIDEA). | | | | | | | | | | | | | |
| *Hydreionocrinus Scoticus*, De Kon. | x | | | | | | | x | | | | | |
| *Pisocrinus globularis*, De Kon. | x | | | | | | x | x | | | | | |
| *Platycrinus trigintidactylus*, Austin. | x | | | | | | | x | | | | x | x |
| *Poteriocrinus crassus*, Miller. | x | | | | | | x | x | x | x | x | x | x |
| ,, *nuciformis*, M'Coy. | x | | | | | | | | | | | | |
| ,, *quinquangularis*, Miller. | x | | | | | x | x | x | | | | | |
| ,, *spissus*, De Kon. | | | | | | x | x | | | | | | |
| ,, *tenuis*, Miller. | | | | | | | x | | | | | | |
| *Rhodocrinus*, sp. (?) | | | | | | | | | | | | x | |
| ECHINODERMATA (HOLOTHURIDEA). | | | | | | | | | | | | | |
| *Cheirodota* (?) *Traquairii*, Ether. | x | | | | | | | | | | | | |
| ,, (?) *Robertsoni*, Ether. | | | | | | x | | | | | | | |
| ANNELIDA. | | | | | | | | | | | | | |
| *Ortonia carbonaria*, J. Young. | x | | | | | | x | x | | | | | x |
| *Serpulites carbonarius*, M'Coy. | x | x | x | | | | x | x | | x | x | | |
| ,, *membranaceus*, M'Coy. | x | | x | x | | | x | x | | x | x | x | x |
| *Spirorbis caperatus*, M'Coy. | x | | x | x | | x | x | | x | | | | x |
| ,, *spinosus*, De Kon. | | | | | | | | | x | | | | |
| *Vermilia minuta*, Brown. | | | | | | x | x | | x | | | | |
| CRUSTACEA (OSTRACODA). | | | | | | | | | | | | | |
| *Bairdia ampla*, Reuss. | | | | | | | | | x | | | | |
| ,, *brevis*, J. and K. | | | | | | x | | | | | x | | |
| ,, *curta*, M'Coy. | | | | | | | | x | | x | | | x |
| ,, *Hisingeri*, Münst. | | | | | | x | | | x | | | | |
| ,, *plebeia*, Reuss. | | | | | | x | | | | | | | |
| ,, *subelongata*, J. and K. | x | | | | | x | | | | | | | |
| *Beyrichia bituberculata*, M'Coy. | x | | | | | x | | x | | | | | |
| ,, *multiloba*, Jones. | x | | | | | x | | | | | | | |
| ,, *radiata*, J. and K. | | | | | | x | | | | | | | |
| *Carbonia* (?) *Carlottæ*, J. and K. | | | | | | x | | | | | | | |
| *Cythere cuneola*, J. and K. | x | | | | | x | | | | | | | |
| *Cytherella simplex*, J. and K. | x | | | | | | | | | | | | |
| ,, *inflata*, Münst. | | | | | | x | | | | | | | |
| *Kirkbya Permiana*, Jones. | | | | | | x | | | | | | | |
| ,, *Urei*, Jones. | x | | | | | x | | x | | | | | |
| *Leperditia Okeni*, Munst., and vars. | x | | | | | x | | | | x | x | x | |
| *Polycope Youngiana*, J. and K. | | | | | | | | | | x | | | |
| CRUSTACEA (TRILOBITA). | | | | | | | | | | | | | |
| *Phillipsia Eichwaldi*, Fischer. | x | | | | | x | x | | | | | | |
| ,, ,, var. *mucronata*, M'Coy. | x | | | | | | x | | | x | x | | |

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| SPECIES. | LOWER LIMESTONE SERIES. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
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| CRUSTACEA (PHYLLOPODA). | | | | | | | | | | | | | |
| *Dithyrocaris glabra*, Woodw. & Eth. | x | x | x | x | | | | | | | | | |
| ,, *granulata*, Woodw. & Eth. | x | x | x | | | | | | | | | | |
| ,, *ovalis*, Woodw. & Eth. | x | | x | x | | | | | | | | | |
| ,, *testudineus*, Scouler. | x | x | x | x | x | | x | | x | | | | |
| ,, *tricornis*, Scouler. | x | x | | x | | | | | | | | | |
| CRUSTACEA (PODOPHTHALMATA). | | | | | | | | | | | | | |
| *Palæmysis*(N.Genus).B.N.Peach,MS | x | | | x | | | | | | | | | |
| *Palæocrangon*, N.Sp., Salter. | x | | | x | | | | | | | | | |
| *Palæsquilla Pattoni*,N.G.,Peach,MS | x | | | x | | | | | | | | | |
| *Anthrapalæmon Couttsii*,Peach, MS | x | | | x | | | | | | | | | |
| ANNULOSA (ARACHNIDA). | | | | | | | | | | | | | |
| *Eoscorpius*, sp., Meek & Worthen. | x | | | | | | | | x | | | | |
| *Glyptoscorpius*, sp., B.N. Peach. | x | | | | | | | | | | | | |
| POLYZOA. | | | | | | | | | | | | | |
| *Actinostoma fenestratum*, Y. and Y. | x | | | | | x | | | x | | | | |
| *Archæopora nexilis*, De Kon. | x | | | | | x | x | x | x | | | | x |
| *Ascodictyon radians*, Nich. & Ether. (doubtful form). | | | | | | x | | | | | | | |
| *Ceriopora interporosa*, Phill. | x | | | | | x | | | x | x | x | | |
| ,, *similis*, Phill. | | | | | | x | | | | | | | |
| *Diastopora megastoma*, M'Coy. | x | | | | | x | x | x | x | x | x | x | x |
| *Fenestella ejuncida*, M'Coy. | | | | | | | | x | | | | | |
| ,, *Morrisii*, M'Coy (?). | x | | | | | | | | | | | | |
| ,, *multiporata*, M'Coy. | | | | | | x | | | | | | | |
| ,, *plebeia*, M'Coy. | x | | | | | x | | x | x | x | x | x | x |
| ,, *tenuifila*, Phill. (?). | x | | | | | x | | x | x | | | | |
| ,, *tuberculo-carinata*, Ether. | x | | | | | x | | x | | | | x | |
| *Hyphasmopora*, Buskii, Ether. | | | | | | x | | | x | | | | |
| *Pinnatopora* (*Glauc.*) *aspera*, Y. & Y. | | | | | | | | | x | | | | |
| ,, *elegans*, Y. and Y. | | | | | | x | | | x | | | | |
| ,, *flexicarinata*, Y. & Y. | | | | | | x | | x | x | | | | |
| ,, *laxa*, Y. & Y. | | | | | | x | | | x | | | | |
| ,, *marginalis*, Y. & Y. | | | | | | x | | | x | | | | |
| ,, *retroflexa*, Y. & Y. | | | | | | x | | | x | | | | |
| ,, *stellipora*, Y. & Y. | | | | | | x | | | x | | | | |
| ,, ,, var. *spinosa*, Y.& Y. | | | | | | x | | | x | | | | |
| *Polypora tuberculata*, Prout. | | | | | | | | | x | | | | |
| *Ptilodictya parallela*, Phill. | x | | | | | x | | | x | x | x | x | x |
| *Rhabdomeson gracile*, Phill. | | | | | | x | | x | x | | | | |
| ,, *rhombiferum*, Phill. | | | | | | x | x | | x | | | | |
| *Synocladia carbonaria*, Ether. | | | | | | x | x | x | | | | | |
| ,, *fenestelliformis*, J. Y. | | | | | | x | | x | | | | x | x |

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| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
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| BRACHIOPODA. | | | | | | | | | | | | | |
| *Athyris ambigua*, Sow. | x | x | x | x | x | x | x | x | x | x | x | x | x |
| ,, *plano-sulcata*, Phill. | x | | | | | | | | | | x | | x |
| ,, *Royssii*, Lev. | | | | | | | | | | x | x | x | |
| *Chonetes Buchiana*, De Kon. | x | | | | | | | | | | | | |
| ,, *Laguessiana*, De Kon. | x | x | x | x | x | x | x | x | | | x | x | x |
| ,, *polita* (?), M'Coy. | x | x | x | x | x | | | | | x | x | x | |
| *Crania quadrata*, M'Coy. | x | | | | x | x | x | x | x | | x | | |
| *Discina nitida*, Phill. | x | x | x | x | x | x | x | x | x | x | x | x | x |
| *Lingula mytiloides*, Sow. | x | | | | | x | x | x | | x | x | x | x |
| ,, *Scotica*, Dav. | | | | | x | | | | | | | | |
| ,, *squamiformis*, Phill. | x | x | x | x | x | x | x | x | | | x | | |
| *Orthis Michelini*, Lev. | x | | | | | x | | | | x | x | x | x |
| ,, *resupinata*, Martin. | x | | | | | x | | | | x | x | x | x |
| *Productus aculeatus*, Martin. | | | | | | | | | | | | | x |
| ,, *cora*, D'Orb. | x | | | | | | | | | | | x | |
| ,, *costatus*, J. de C. Sow. | | | | | | | | | | | | x | |
| ,, *fimbriatus*, J. de C. Sow. | | | | | | | | | | | x | | |
| ,, *giganteus*, Martin. | x | | | | | x | x | x | | x | x | x | x |
| ,, *latissimus*, J. de C. Sow. | | | | | | | | | | | x | x | x |
| ,, *longispinus*, Sow. | x | x | x | | x | x | x | x | x | x | x | x | x |
| ,, *muricatus*, Phill. | | | | | | x | | | | | | x | x |
| ,, *punctatus*, Martin. | | | x | | | x | | x | | x | x | x | x |
| ,, *scabriculus*, Martin. | x | | | | | | | | | | | x | x |
| ,, *semireticulatus*, Martin. | x | x | x | x | | | x | x | | x | x | x | x |
| ,, ,, var. *Martini*, Sow. | | | | | | | x | | | | | | |
| ,, *spinulosus*, Sow. | | | | | | | | | | | | x | x |
| ,, *undatus*, Defr. | | | | | | | | | | | | x | x |
| ,, *Youngianus*, Dav. | x | | | | | x | x | | | x | x | x | x |
| *Retzia radialis*, Phill. | | | | | | | x | x | | | | | |
| *Rhynchonella pleurodon*, Phill. | x | x | x | x | x | x | x | x | x | x | x | x | x |
| ,, *pugnus* (?) Martin. | | | | | | | | | | | x | | |
| *Spirifera glabra*, Martin. | x | x | | | | | | x | | x | x | | x |
| ,, *lineata*, Martin. | x | | | | | x | x | x | x | x | | x | |
| ,, *ovalis*, Phill. | | | | | | | | | | | | x | x |
| ,, *trigonalis*, Martin. | | | | | | | | x | | x | x | | |
| ,, ,, var. *bisulcata*, Sow. | x | | | x | | | | x | | | | x | |
| ,, *Urei*, Flem. | x | | | x | | | | | | x | x | | x |
| *Spiriferina cristata*, var. *octoplicata* Sow. | x | x | x | | | | x | x | x | x | | x | x |
| ,, *insculpta*, Phill. | | | x | x | | | | x | | | | | |
| *Streptorhynchus crenistria*, Phill. | x | x | x | x | | | | | x | x | | x | x |
| ,, ,, var. *radialis*, Phill. | | | | | | | | | | x | | | |
| *Strophomena rhomboidalis*, Wahl. | | | | | | | | | x | | | | |
| ,, var. *distorta*, J. de C. Sow. | | | | | | x | | x | | | | | |
| *Terebratula hastata*, Sow. | | | | | | x | x | x | | | x | x | |
| ,, var. *sacculus*, Martin. | | | | | | | | | | | | | |

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| LAMELLIBRANCHIATA (MONOMYARIA). | | | | | | | | | | | | | | |
| *Aviculopecten arenosus*, Phill. | x | x | x | x | | x | | | | | x | x | | |
| ,, *cælatus*, M'Coy. | | | | | | | x | | | | x | x | | |
| ,, *clathratus*, M'Coy. | x | | | | | | | | | | | | | |
| ,, *docens*, M'Coy. | x | x | | x | | | | | | | | | | |
| ,, *ellipticus*, Phill. | x | x | x | x | | | | | | | | | | |
| ,, *elongatus*, M'Coy. | x | | | | | | | | | | | | | |
| ,, *fimbriatus*, Phill. | | | | | | | | x | | | | | | |
| ,, *granosus*, Phill. | x | | | | | | | | | | | | | |
| ,, *interstitialis*, Phill. | x | x | x | x | | | | | | | x | x | | |
| ,, *Knockonniensis*, M'Coy | | | | | | | x | x | | | | | | |
| ,, *ornatus*, Ether. | x | x | x | x | | | | x | | | x | x | | |
| ,, *papyraceus*, Goldf. | x | x | x | x | | | | | | | | | | |
| ,, *plicatus*, Sow. | | | | | | | x | | | | | | | |
| ,, *semicircularis*, M'Coy. | | | | | | x | x | x | | | x | x | x | |
| ,, *serratus*, M'Coy. | | | | | | | | x | | | | | | |
| ,, *simplex*, De Kon. | x | | | | | | x | x | | | | | | |
| ,, *subelongatus*, M'Coy. | x | | | | | | x | | | | | | | |
| *Pecten* (*Entolium*) *Sowerbii*, M'Coy. | x | x | x | x | x | | x | x | | | x | x | | |
| *Pinna flabelliformis*, Mart. | x | | | | | x | x | x | | x | x | x | x | |
| *Posidonomya corrugata*, Ether. | x | x | x | x | x | x | x | x | | | x | | | |
| ,, *membranacea*, M'Coy. | x | | x | | | | | | | | | | | |
| *Pteronites angustatus*, M'Coy. | x | | | | | | | | | | | | | |
| ,, *persulcatus*, M'Coy. | x | | | | | | | | | | x | x | x | |
| LAMELLIBRANCHIATA (DIMYARIA). | | | | | | | | | | | | | | |
| *Allorisma sulcata*, Flem. | | | | | | | | x | | | | | | |
| *Arca*, sp. (?) | | | | x | | | | | | | x | x | | |
| *Cardiomorpha oblonga*, Sow. | | | | | | | | x | | | | | | |
| *Conocardium aliforme*, Sow. | x | | | | | x | | x | | | | | | |
| ,, *armatum*, Phill. | | | | | | | x | | | | | | | |
| *Cypricardia rhombea*, Phill. | | | | | | | x | x | | x | | | | |
| *Edmondia Egertoni*, M'Coy. | x | | | | | | | x | | | | | | |
| ,, *rudis*, M'Coy. | | | | | | | | x | | | | | | |
| ,, *unioniformis*, Phill. | | | | | | | x | x | | | | | | |
| *Leda leiorhynchus*, M'Coy. | x | | | | | | | | | | x | | | |
| *Leptodomus costellatus*, M'Coy. | x | | | | | | x | x | | | | x | | |
| ,, *fragilis*, M'Coy. | x | x | x | x | | | | | | | | | | |
| *Modiola lingualis*, Phill. | x | | | | | | | | | | | | | |
| ,, small, sp. (?) | x | | | | | | | | | | | | | |
| ,, *lithodomoides*, Ether. | x | | | | | | | | | | | | | |
| ,, *megaloba*, M'Coy. | x | | | | | | | | | | | | | |
| ,, *subparallela*, Portl. | | | | | | | x | | | | | | | |



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| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
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| DIMYARIA.—*Continued.* | | | | | | | | | | | | | |
| *Myalina*, sp. (?) | x | x | x | x | x | | | x | | | | | |
| ,, *Verneuilii*, M'Coy. | x | | | | | | | | | x | | | |
| *Nucula acuta*, Sow. | x | | | | | | | | | | | | |
| ,, *brevirostris*, Phill. | | | | | | | | | | x | | | |
| ,, *gibbosa*, Flem. | x | x | x | x | x | x | x | x | | x | x | x | |
| ,, *lævirostrum*, Portl. | x | | | | x | | x | | | | | | |
| ,, *lineata*, Phill. | x | x | x | x | x | | | | | x | | | |
| ,, *luciniformis*, Phill. | | | | | | | | | | x | x | | |
| ,, *unilateralis*, M'Coy. | | | | | | | x | x | | | | | |
| *Nuculana attenuata*, Flem. | x | x | x | x | x | x | x | x | | x | x | | |
| *Sanguinolites iridinoides*, M'Coy. | x | | x | | | | | | | | x | x | |
| ,, *radiatus*, Portl. | x | | x | | | | | | | | | | |
| ,, *subcarinatus*, M'Coy. | x | | | | | x | | x | | | | | |
| ,, *tricostatus*, Portl. | | | | | | x | | x | | | | | |
| ,, *variabilis*, M'Coy. | | | | | | x | | x | | | | | |
| *Schizodus axiniformis*, Phill. | x | | | x | | | | x | | | | | |
| ,, *carbonarius*, Portl. | x | | | x | x | | | x | | | | | |
| ,, *deltoideus*, Phill. | | | | | | | | x | | | | x | |
| ,, *orbicularis*, M'Coy. | | | | | | | | x | | | | x | |
| *Solenomya primæva*, Phill. | | | | | | | | | x | | | | |
| *Yoldia intermedia*, Ether. | | | | | | | | | | x | x | | |
| GASTEROPODA. | | | | | | | | | | | | | |
| *Aclisina elongata*, Flem. | | | | | | x | | x | x | | | | |
| *Dentalium ingens*, De Kon. | | | | | x | | | | | x | | | |
| ,, *inornatum*, M'Coy. | | | | | x | | | | | | | | |
| ,, *priscum*, Goldf. | | | | | | x | | | | | | | |
| ,, *Scoticum*, J. Young. | x | x | x | x | x | | | | | | | | |
| *Eulima Phillipsiana*, De Kon. | x | | | | | | | | | | | | |
| *Euomphalus carbonarius*, Sow. | x | | | x | | | | | | x | x | | |
| ,, *Dionysii*, Goldf. | x | | | | | | | x | | | | | |
| ,, *pentangulatus*, Sow. | x | | | | | | | | | | | | |
| ,, *tuberculatus*, Flem. | | | | | x | | | | | | | | |
| *Loxonema constricta*, Mart. | | | | | | x | | | | x | | | |
| ,, *curvilinea*, Phill. | | | | | | | | | | x | x | | |
| ,, *Lefebvrei*, Lév. | | | | | | | | | x | x | x | | x |
| ,, *polygyra*, M'Coy. | x | | | | | | | | | | | | |
| ,, *rugifera*, Phill. | | | | | | | | | x | x | x | | |
| ,, *scalaroidea*, Phill. | x | | | | | x | | | x | | | | |
| ,, *Urei*, Flem. | | | | | | x | | x | x | | | | |
| *Macrocheilus acutus*, Sow. | | | | | | | | | | x | | | |
| ,, *fusiformis*, Sow. | | | | | | | | | | x | | | |
| ,, *imbricatus*, Sow. | | | | x | | | x | | | x | | | |
| ,, *Michotianus*, De Kon. | x | | | | | | x | x | x | | | | |
| *Murchisonia quadricarinata*, M'Coy. | | | | | | | | x | x | | | | |
| ,, *striatula*, De Kon. | | | | | | x | x | | | | | | |
| *Naticopsis elongata*, Phill. | x | | x | | | | | x | x | x | x | | |

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| SPECIES. | LOWER LIMESTONE SERIES. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
| | Limekilns Quarry. | Breusterland Mines. | Glebe Quarry. | Kirktonholm Mines. | Burnbrae Mine. | Capelrig Quarry. | Calderside Mines. | Newfield Limestone Pit. | Hairmyres Quarries. | Thornton Quarries. | Braehead Quarry. | Crosshouse Quarry. | South Shields Quarry. |
| GASTEROPODA.—*Continued.* | | | | | | | | | | | | | |
| *Naticopsis plicistria*, Phill. | | | | | | | | X | X | X | X | | |
| ,, *variata*, Phill. | | | | | | | | | X | | | | |
| *Platyceras neritoides*, Phill. | | | | | | | X | X | | | | | |
| *Pleurotomaria conica*, Phill. | | | | X | | | | | X | | | | |
| ,, *contraria*, De Kon. | X | X | X | X | | X | | X | | | | | X |
| ,, *Frenoyana*, De Kon. | X | | | | | | | | | | | | |
| ,, *Galleottiana*, De Kon. | | | | | | | | | X | | | | |
| ,, *monilifera*, Phill. | X | | | | | | | | | X | | | |
| ,, sp. (?) | X | X | X | X | X | | | | | | | | |
| ,, *Yvanii*, Lev. | X | | | | | | | | | X | | | |
| *Strobœus subulatus*, M'Coy. | | | | | | | | | X | | | | |
| *Trochus lepidus*, De Kon. | X | X | X | X | X | | | | | | | | |
| ,, sp. (?) | X | | | | | | | | | | | | |
| ,, *serrilimba*. | X | | | | | | | | | | | | |
| HETEROPODA. | | | | | | | | | | | | | |
| *Bellerophon cornu-arietis*, Sow. | | | X | | | | | | | | X | | |
| ,, *decussatus*, Flem. | X | | | | | X | | | | X | | | |
| ,, ,, var. *striatus*, Flem. | X | | X | | | | | | | X | | | |
| ,, *Duchastelli*, Lév. | X | | | | | | | | | | | | |
| ,, *Dumontii*, D'Orb. | X | | X | | | | | | | X | | | |
| ,, *Larcomi*, Portl. | | | | | | | | | X | | | | |
| ,, *Oldhamii*, Portl. | | | | | | | | | | X | | | |
| ,, *Urei*, Flem. | X | X | X | X | X | X | X | X | X | X | X | | |
| PTEROPODA. | | | | | | | | | | | | | |
| *Conularia quadrisulcata*, Sow. | X | | X | | X | X | X | X | | | | | |
| CEPHALOPODA. | | | | | | | | | | | | | |
| *Actinoceras giganteum*, Sow. | X | X | X | X | X | | X | X | | | | | |
| *Cyrtoceras rugosum*, Flem. | X | X | X | X | X | X | | | X | | | | |
| ,, *unguis*, Phill. | X | | | | | | | | | | | | |
| *Goniatites crenistria*. | X | X | X | X | | | | | | | | | |
| ,, *diadema*, Goldf. | | | | | | | | | | | X | | |
| ,, *excavatus*, Phill. | X | | | | | | | | | X | | | |
| ,, *Gilbertsoni*, Phill. | X | | | | | | | | | X | | | |
| ,, *implicatus*, Phill. | X | | | | | | | | | | | | |
| ,, *Looneyi*, Phill. | X | | | | | | | | | | | | |
| ,, *micronotus*, Phill. | X | | | | | | | | | X | | | |
| ,, *mutabilis*, Phill. | X | | | | | | | | | X | | | |
| ,, *sphæricus*, Mart. | X | | | | | | | | | | | | |
| ,, *striatus*, Sow. | X | X | X | | X | | | | | | | | |
| ,, *striolatus*, Phill. | X | | | | | | | | | | | | |

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| SPECIES. | LOWER LIMESTONE SERIES. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
| | Limekilns Quarry. | Breusterland Mines. | Glebe Quarry. | Kirktonholm Mines. | Burnbrae Mine. | Capelrig Quarry. | Calderside Mines. | Newfield Limestone Pit. | Hairmyres Quarries. | Thornton Quarries. | Braehead Quarry. | Crosshouse Quarry. | South Shields Quarry. |
| CEPHALOPODA—*Cont.* | | | | | | | | | | | | | |
| *Goniatites vesica*, Phill. | x | | | | | | | | x | | | | |
| *Nautilus biangulatus*, Sow. | | | | x | | | | | | x | x | | |
| ,, *globatus*, Sow. | | | | | | | | x | | x | | | |
| ,, *ingens*, Mart. | x | | | | | | | | | | | | |
| ,, (*Discites*) *Leveilleanus*, De Kon. | | | | x | | | | x | | | | | |
| ,, *nodiferus*, Armstrong. | x | | | x | | | | | | | | | |
| ,, (*Discites*) *quadratus*, Flem. | | | | | | | | x | | x | | | |
| ,, ,, *sulcatus*, Sow. | x | x | x | x | | | | | | | | | |
| ,, *tuberosus*, M'Coy. | x | | | x | | | | | | | | | |
| *Orthoceras attenuatum*, Flem. | x | x | x | x | x | x | x | | | x | x | | |
| ,, *Breynii*, Mart. | | | | | | | | x | | | | | |
| ,, *cinctum*, Sow. | | | x | | | | | | | | | | |
| ,, *lævе*, Flem. | | | | x | | x | x | x | | | | | |
| , *pygmæum*, De Kon. | | | | | | | | | | | x | | |
| ,, *undatum*, Flem. | x | x | x | x | x | x | x | | | x | | | |
| ,, *subcentrale*, De Kon. | | | x | | | | | | | | | | |
| *Poterioceras cordiforme*, Sow. | | | | | | | x | x | | | | | |
| ,, *fusiforme*, Sow. | x | | | | | | | | | | | | |
| ,, *ventricosum*, M'Coy. | | | | | | | | x | | | | | |
| PISCES (SELACHIAN). | | | | | | | | | | | | | |
| *Chomatodus obliquus*, Ag. | x | | | x | | | x | | | x | x | | x |
| *Cladodus mirabilis*, Ag. | x | | x | | | | | | | | | | |
| *Cochliodus contortus*, Ag. (?) | x | x | x | x | | | | | | x | x | | x |
| *Ctenacanthus brevis*, Ag. | x | | | | | | | | | | | | |
| *Ctenopetalus serratus*, Ag. | x | | | | | | | | | x | | x | x |
| *Deltodus*, sp. (?) | | | | | | | | | | | | | x |
| *Deltoptychius* (*Cochliodus*) *acutus*, Ag. | | | | | | | | | | | | | x |
| *Diplodus* (*Pleuracanthus*) *gibbosus*, Ag. | x | | | | | | | | | | | | |
| *Fissodus Pattoni*, Ether. | | | | x | | | | | | | | | |
| *Gyracanthus formosus*, Ag. (?) | x | | x | | | | | | | | | | |
| ,, *tuberculatus*, Ag. (?) | | | x | | | | | | | | | | |
| *Helodus mammillaris*, Ag. | | | | | | | x | | | | x | | x |
| *Homocanthus microdus*, Ag. | | | | | | | | | | | x | | |
| *Leptacanthus Jenkinsoni*, M'Coy. | | | | | | | x | | | | | | |
| *Onchus*, sp. (?) | x | | x | | | | | | | | | | |
| *Oracanthus Milleri* (spine), Ag. | | | x | x | | | | | | | | | |
| *Orodus cinctus*, Ag. | | | | | | | x | | | | | | |
| *Petalodus Hastingsiæ*, *Owen*. | x | | x | | | | | x | | | x | x | x |
| ,, *lobatus*, Ether. | | | | | | | | | | | | x | |
| *Petalorhynchus Benniei*, Ether. | | | | | | | | | | | | x | x |
| ,, *psittacinus*, Ag. | | | | | | x | | | | x | | x | |

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| SPECIES. | LOWER LIMESTONE SERIES. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CALDERWOOD GROUP. | | | | | | | | BRAEHEAD GROUP. | | | | |
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| PISCES (SELACHIAN)—*Continued.* | | | | | | | | | | | | | |
| *Petrodus patelliformis*, M'Coy. | x | | | | | | | | | | x | | |
| *Pœcilodus aliformis*, Ag. | x | | | x | | x | | | | | | | |
| ,, *Jonesii*, Ag. | x | | | | x | | | | | x | x | | x |
| ,, *obliquus*, Ag. | x | | x | | x | | | | | | x | | |
| *Polyrhizodus radicans*, Ag. | | | | | | | | | | | | | x |
| *Psammodus porosus*, Ag. | x | x | x | x | | x | x | x | | x | | x | x |
| ,, *rugosus*, Ag. | x | | x | | | | | | | | | | x |
| *Psephodus magnus*, Ag. | x | | | | x | | x | x | x | x | x | x | x |
| *Tomodus convexus*, Ag. | x | | | | | | x | | | | | | |
| *Xystrodus* (*Cochliodus*) *striatus*, Ag. | | | | | | | | x | | | x | | x |
| PISCES (GANOID). | | | | | | | | | | | | | |
| *Amphicentrum granulosum*, Dr. J. Y. | x | | | | | | | | | | | | |
| *Cœlacanthus*, (?) sp. (?) Ag. | x | | | | | | | | | | | | |
| *Elonichthys*, (?) (*Palœoniscus*), sp., Traquair. | x | x | | x | x | | | | | | x | | |
| *Eurynotus crenatus*, Ag. | x | | | | | | | | | | | | |
| *Gyrolepis Rankinii*, Ag. | x | | x | x | | | | | | x | | | |
| *Megalichthys Hibberti*, Ag. | x | x | x | x | x | | x | | | x | x | | |
| *Platysomus declivus*, Ag. | | | | | | | | | | x | x | | |
| *Rhizodopsis granulatus*, Ag. | | | | | | | | | | x | x | x | |
| *Rhizodus Hibberti*, Ag. | x | | x | | x | x | x | x | | x | x | | x |
| *Strepsodus sauroides*, Hux. | x | | | | | | | | | | | | |

**Note on the HOLOTHURIDEA in the preceding list. (Sept. 1884.)**

**For description and figures of the two species noted here see the *Proceedings* of the Royal Physical Society of Edinburgh, 1880-81-82, p. 183, plates V., VI., in a paper by Mr. R. Etheridge, jun., "On the occurrence of the scattered remains of Holothuridea in the Carboniferous Limestone of Scotland." The occurrence of Holothurian remains in the shales of East Kilbride was first recorded in the "Memoirs of the Geological Survey of Scotland," explanatory sheet 23, 1873, p. 98, the discovery having been made by Mr. James Bennie, Fossil Collector to the Survey, and who has been a member of our Society since the first session, 1858-9. The first traces of these organisms found consisted of wheel-like spicules only, but in 1881 Mr. Etheridge described other spicules in the form of perforated plates, anchors, and crosses, arranging them into 3 genera and 4 species. Since that date Mr. Bennie has extended his researches, finding Holothurian remains not only in the Edinburgh and Glasgow districts, but also in the border counties of Scotland and England, and in so many horizons that he is convinced the Holothuridea were as common in the Carboniferous seas as in those of recent times.**

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## No. XXXIV.—Random Notes on the English Lake District.

By James White.

[Read 11th October, 1883.]

Without attempting to discuss the question whether beauty is an objective or a subjective quality, whether resident in the mind of the observer or in the thing observed, it must be admitted that there are certain external objects which do command the general consent of mankind to possess that attribute—certain songs which we all and always like to hear; certain musical compositions which all admire; certain scenery which has a universal attraction.

It might be doubtful if there are many to whom these external objects present precisely the same aspect, or, if they could define their own emotions, would give exactly the same account of them. Of the thousands who every year flock to see the magnificent colonnades of Staffa, the motives in all their details might well-nigh be as varied as the individuals, an outing, to see what others have seen, something *outré*, while Edwin and Angelina must go somewhere, and so they go there. I rather fancy that those who look at such a spot from a geological point of view, whose minds care to realize its history, to conceive of it as a flow of burning lava before which no living thing could for a moment hold its own, or who endeavour to estimate those remarkable laws in virtue of which in cooling it has become broken up into the striking form in which we now see it, whose fancy cares to dwell on the reasons why, a mere fragment of what it has been, it is left rearing its head amidst the fierce western seas, are by far in the minority; and yet it is only those who get behind such scenes geologically, and who thus to a keener perception of the present add a vivid image of the past, who can be said to see them at all.

The English Lake District is one of those spots which yearly attracts its thousands of visitors, and a cursory review of some of its leading geological features, and how they have come about, forms the object of these random notes. It is only a rough sketch and a glance at its leading physical features. The district is extensive, is an exceedingly complicated one, and has proved as fertile a field for geological research as it is attractive to the tourist. I have beside me a printed list of 350 books or papers

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all bearing more or less on the subject of its geology. In the midst of such a mass of literature, it would be very hard for a casual visitor to say anything that is new. It is rich in natural scenery, and has inspired many a glowing line; it is rich in those inorganic products which minister to human wants—coal, copper, iron, zinc, lead, graphite, slate, lime are amongst them, and the principal. Its mineral ores have been worked for 2,000 years. But to our tale.

This district, then, occupies a corner in the extreme north-west of England, embracing part of the counties of Cumberland, Westmoreland, and Lancaster, and is somewhat in the form of an ellipse, whose longest diameter, north to south, is about fifty-one miles, and the shortest about thirty-seven. Within this area, which is distinctly marked off from the surrounding country, there are comprised sixteen of what may be called lakes, with an indefinite number of small "tarns." The largest sheet of water is Windermere, eleven miles in length. It is further of interest to notice that from the high ground, of which Helvellyn may be taken as the centre, though it is not the highest point, the long lakes radiate outwards in all directions like spokes from the nave of a wheel; and this seems to supply us with a hint as to their common origin, whatever that may have been. The district consists fundamentally of a central dome of rocks, which may be classed roughly as of Lower Silurian age, flanked on every side by Carboniferous strata, which are succeeded by bands of Permian and patches of Secondary rocks. Of course this central dome has not been so long in the world without experiencing many of the vicissitudes to which rocks are everywhere exposed; its top has been entirely removed, and numerous heights, which are greatly less elevated than the originals must have been, occupy its place, and many faults and flexures have added their quota to the disintegration of the locality. If we add a large share of those eruptive and metamorphic agencies which have everywhere played so important a part in the formation and modification of the crust of the earth, we come to have an exceedingly varied country, both above and below ground, which in its history and results has been the source of that great interest with which geologists have regarded it. The late Rev. Mr. Clifton Ward thus summarized the rocks of the district—Lower Silurians, about 10,000 feet, overlaid by volcanic rocks, about 12,000 feet, and Upper Silurians, about 14,000 feet.

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Out of the many interesting topics of thought and observation which this district presents I select three, being those most attractive to my own mind—first, its elevation; second, its denudation by ordinary atmospheric agencies; and third, its glaciation.

*First, Elevation.*—That this was not accomplished all at once, but is the result of several movements extending through long geological time, is shown by Professor Sedgewick, Messrs. Hopkins, Clifton Ward, and others. Besides several minor unconformities amongst the Silurian rocks themselves, there are two principal ones, viz., the Carboniferous beds on its outermost border rest upon the upturned edges of the Silurian rocks, the Permian strata again resting upon and overlapping the inclined edges of the Carboniferous rocks; so that we have several distinct epochs of upheaval, each separated from the other by an absolutely indefinite interval of time.

Whatever hypothesis we may adopt as to the condition of the interior of the globe, whether we regard it as gaseous, liquid, or solid, one thing is very evident, that its crust is extremely mobile, developing itself in numerous instances in bosses and domes of varying altitudes and areas, and sometimes running in long anticlinal ridges for hundreds of miles. Hills of this sort are easily distinguished by the dip of the strata from those which are formed by the denudation of the softer surrounding masses, and also from those which are formed by the piling up of volcanic ejectamenta at the mouth of an orifice, all of such agencies having played their part in diversifying the surface of the earth and giving those varieties of climate and soil which are so powerful agents in modifying the living forms which inhabit it.

The causes of those subterranean movements which result in the elevation of great masses of strata have long engaged the attention of physicists, and are by them ascribed to the very simple one of the hard outer shell, crust or rind of the globe, being compelled to adapt itself to a gradually decreasing interior, decreasing by loss of heat; in fact a larger sphere being forced to occupy the place of a smaller one—irregularities of contour, flexures, and fractures being, of course, the result.

These are things which in our little rambles or excursions to the country, either as individuals or as a society, we have few opportunities of observing. It is summer-time, and Nature with her soil-clad and verdure-clad hills and dales, seems quite disposed to

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cover up and conceal her little faults and failings from the eyes of too prying geologists, and then the sections we see, either natural or artificial, are so shallow that we must just have recourse to the experience and observation of those whose opportunities are better than our own to verify the conclusions to which this theory points. In the Swiss Alps the flexuring and displacement of rocks are seen to great advantage, and therefore most text-books are furnished with drawings of some of those phenomena. I quote one example from a review in *The Geological Magazine* for 1879 of a work on the formation of mountains by Professor Heim, of Zurich, in which he describes one of those flexures or inversions of strata which he had traced over an area of 464 square miles, or something like the following :—If a mass of strata about twenty miles broad were lifted at Glasgow and folded over so as to reach Rothesay, with the axis of the fold at Greenock, we would then have an inversion of strata of fully 400 square miles, or less than the one Professor Heim has actually traced out.

Dr. Archibald Geikie in his new geological text-book, quoting from the above-named author, states that the horizontal compression of the whole Alpine chain amounts to about 74 miles—that is to say, that two points on the opposite sides of the chain have, by the folding of the crust that produced the Alps, been brought 74 miles nearer to each other than they were before the movement. An example on a smaller scale of this displacement of rocks by horizontal compression occurs in our own neighbourhood, in the small coalfield of Quarrelton near Johnstone, where, in sinking vertically, the beds are found to be repeated, and lie folded upon each other three times like a widely extended letter **Z**.

Such are examples of the disturbances which sometimes go on amongst the quiet everlasting hills, quiet indeed with us so far as the memory of the oldest inhabitant is concerned or even that of the race itself, but other regions of the world have of late been furnishing proofs of how grossly inappropriate such epithets are as applied to them. I am sure every one in this room has read with the most profound and painful interest the accounts which have come to hand of the terrible eruptions which occurred last August in the Sunda Straits, where, amongst many other details, it is mentioned that in the Island of Java the entire chain of the Kandang mountains, which extended along the coast in a semi-circle for about 65 miles, sank beneath the sea in a single night.

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However awful such events may be, and however productive of human suffering and destructive to human life and property, yet every geologist knows that they are merely the result of natural laws which have been in unvarying operation ever since the thinnest film of a crust was formed on the surface of the globe, and which must continue to operate so long as there is a single cavity within its mass.

The generalization first indicated by Dana of the permanency of our continents and of the great ocean beds, and now accepted by many leading geologists as a sound doctrine, seems but an extension of this idea or observation. Whilst this acceptance is by no means universal, yet the facts and arguments in its favour seem to be of very great weight, and some of these may be here enumerated. 1st. On the universally accepted hypothesis that the earth is a cooling and contracting body, the corrugations on its surface would naturally continue to deepen in the same lines on which they were originally formed, as we see always to be the case in any body where we have a soft interior and a less yielding exterior, for example, in dried fruits. 2nd. It is now known that the islands of the great oceans are not the remains of previously existing land formed of sedimentary strata in those regions, but are simply volcanic peaks often capped with coral reefs. 3rd. The zones most favourable for the development of life in the sea are not the deepest parts, but those of more moderate depth, as those of moderate height on land, so that our limestones, by far the greater portions of which are merely organic accumulations, do not represent the deepest parts of the sea, but those of moderate depth only. 4th. The great mass of the derivative rocks which form the crust of the earth are of an arenaceous or argillaceous character and therefore littoral in their origin, shore deposits often exhibiting such features as sun-cracks, footprints of wading birds or reptiles, worm-tracks or casts, ripple-marks, rain-drops, etc., all of which features are certain indications of shore conditions. Then there are other deposits of deltal or estuarine origin, as is shown by the mixing together of marine and freshwater fossils, and by their often containing the remains of land animals and plants. Add to this that the wash of the sea is always towards the land. Such seem to be the principal data on which the generalization rests, but when the leaders of the science, those who, with a special training fitting them for such pursuits, have spent their lives in its

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prosecution, are at variance, it would be foolhardy in those who are mere dabblers to give any very decided opinion. Yet I think the above-named facts must be held to be of very great weight, and that this generalization must be regarded as one of the most interesting of recent years, for by limiting the area of life it seems to afford more hope to the palæontologist of being able ultimately to fill up many of those life-breaks which now mark his series, while to trace out the history of life on the globe must ever be held the profoundest aim, as its completion would be the greatest triumph, of geological science.

*Second, Denudation.*—Notwithstanding the great disturbances to which this district has been subjected, the present "beautiful forms of its mountains and valleys are entirely due to sub-aërial agents" acting on masses of unequal powers of resistance. This will be clear if we consider the immense amount of material which has been removed from its surface since these disturbances took place.

The late Rev. Mr. Clifton Ward, whose experience and intimate knowledge of the district render his observations reliable, shows that from large portions of the area the whole of the Upper Silurian strata, 14,000 feet thick, has been removed, besides 12,000 feet of volcanic rocks, an amount so great that "an Etna in size may once have stood where now are the resting-places of quiet lakes," besides a large portion of the Lower Silurians.

It is worth notice in passing that Professor Heim points out the same thing in regard to the Alps, probably the most disturbed known region in the world. "Denudation," he says, "has absolutely destroyed the original shapes which would correspond to the internal structure of the mountains. The valleys of the Alps are entirely due to erosion. If fissures or syncline lines have in the first place fixed the direction, these must have been far above the present peaks and actual crests, and in strata which have long since disappeared." So much for the action of trivial but insidious agents *plus* indefinite time.

*Third, Glaciation.*—The evidences of ice-action are very abundant in the Lake country. It was one of the localities visited by M. Agassiz in 1840, and the observations made during his visit may be said to have established the glacial theory. It is wonderful how easy it is to see these glacial features now, and how difficult it was to do so before. The question now is not where

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can one go to find them, but where can we go to avoid them? They meet you at every turn—*roches moutonnées*—smoothed and grooved surfaces, mammillated hills, huge boulders, moraines, and last but not least, that irrepressible Boulder-clay. It is of amusing interest to look over the literature of forty or fifty years ago and note the progress of thought and observation since then. Debacles, floods, convulsions, cataclysms, waves of translation, the great Mosaic deluge, etc., etc., were all called into play to account for superficial phenomena, which, it is now seen, are so much better accounted for without them; and accounted for, moreover, by causes which, it is known from other sources, were actually at work. So the debacles, with their attendant train, advocates and all, peacefully take their exit, as ogres, ghosts, and monsters generally have done, and we are left in quietness to reason from what we know to what is more obscure, and not to perfect our knowledge by calling in data the existence of which is more difficult to account for than the phenomena which they are called on to explain.

Writing forty years ago, Dr. Buckland called attention to the great masses of moraine detritus which exist in front of the great vomitories through which the waters of these lakes were discharged, and the first thing which strikes an observer as he enters the district from Penrith on the east is the great masses of gravelly detritus through which the railway cuts. As you get further on you observe the rounded, flowing form of the hills, a form which is at once attributed to the action of ice, and your impressions are confirmed when you reach the top of some of them, as I did to the top of Skiddaw and Helvellyn, both over 3,000 feet high, and observe that on the summit this smoothing goes right across the upturned edges of highly inclined strata. Look up the glens such as Borrowdale, and every projecting crag and knoll are sharply defined and seem to frown at you, but turn and look down, and immediately they are rounded off, transformed into the finest examples of *roches moutonnées*. The little islands on Lake Windermere, where not covered by vegetation, also frequently show the same features. Having an hour to spare till train time, I sauntered into the quiet little churchyard at Windermere, and there, projecting amid the tombstones, memorials of the human past, were two memorials of the great ice age, beautiful examples of *roches moutonnées*, rounded, smoothed, and

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furrowed from the north, the south end terminating quite abruptly. But it is useless to multiply examples—the whole district is teeming with them. Mr. M'Intosh, in a paper printed in the *Quarterly Journal* of the Geological Society, vol. 30, describes the volume of ice as being so great as to travel *across* the hills, ignoring, in its onward progress, valleys 900 feet in depth. Rev. Mr. Clifton Ward also writes on the same subject in great detail.

Thus we see some of the deep-seated and remote causes of the beauty of the Lake District. If it had not been elevated it never could have been denuded; if it had not been denuded we never could have had those deep glens with their picturesque waterfalls, affording food and shelter to so rich a flora, which are but the further developed forms of those "glancing torrents which scaur the mountain side with streaks of glistening sheen," and which, by the striking contrast they exhibit to the hard, bare, busy scenes of every-day life, are welcomed by all dwellers in towns, by all toilers, whether with hand or brain, whether artizan or merchant, as a most merciful relief; nor those mountain-tops, which one has such a strong fancy to ascend and so to seem to take possession of, nor those rich and fertile meadows which yield us freely that which we need for our support, suggesting ideas of comfort and abundance, and which again afford such a pleasing contrast to the less productive if more striking portions of this remarkable region. If it had not been glaciated, its hills and valleys would have wanted much of that softness and sweetness of contour which characterize them; they would have been all grim and fierce and angry. Both agencies are apparent, and the blending of the two gives that variety which is one of its attractions.

Without glaciation we should have had none of those lakes at all, but merely so many tiny rivulets threading their devious and rugged paths to the sea:—

> "No check, no stay these streamlets fear,
> How merrily they go;
> They'll murmur on a thousand years,
> And flow as now they flow."

Rock-bound basins they all are, and their formation is clearly the work of that grim agent. Nor those innumerable "tarns" which

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dimple the hills in every direction, and, like so many little mirrors, reflect the glitter of the summer sun. And do not these erratics even add to the beauty as they certainly do to the interest of the scene? Wanderers often far from home, with their parentage doubtful or wholly unknown, perched no matter where, they are at once the relics and the evidences of a time when certainly there were none to admire them, or to care either for what they were or from whence they came.

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## No. XXXV.—On the Geology of Ardrossan and West Kilbride. By Dugald Bell, *V.P.* With a Section.

[Read 12th April, 1884.]

From Port-Glasgow to Ardrossan, the eastern shore of the Firth of Clyde is generally of a bold and rocky character, bounded by a range of hills in which the well-marked old coast-line, that forms so picturesque a feature of our seaboard, has been cut out at no great distance from the present shore. But between Ardrossan and the Heads of Ayr, the country assumes a more open and level aspect; the hills retreat further into the interior, and a considerable plain, or tract of gently sloping ground, extends outwards from them towards the sea, terminating along the shore in a broad margin of yellow sand. This low-shelving part of the coast marks the seaward extension of the Ayrshire coalfield. It forms, in fact, a great bay scooped out of the softer Carboniferous strata between the points where the Calciferous sandstones and associated igneous rocks emerge from beneath them on either hand. This great bay is divided by two or three projecting points into so many smaller bays, as at Ardrossan, Saltcoats, and Troon. Such points on a coast are always worthy of notice, as indicating rocks which from their superior hardness have more successfully resisted the abrading action of the sea. If they be igneous or eruptive rocks, there is a likelihood that the neighbouring strata will be seen to advantage either protected by them from disintegration or disturbed and uptilted alongside of them.

At Saltcoats and Ardrossan, for example, we find that both these projecting points, of which advantage has been taken to form the

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respective harbours, consist of igneous rocks, partly interbedded and partly intrusive, and that in both instances an interesting series of strata is exposed resting upon them. At Saltcoats the strata belong to the "upper coals" or Coal Measures of Ayrshire; at Ardrossan to the "lower coals" or Carboniferous limestone series.

The Kilwinning and Stevenston corner of the Ayrshire coalfield contains the following seams in descending order, varying from $2\frac{1}{4}$ to $4\frac{1}{2}$ feet in thickness, and separated from each other by from 10 to 15 fathoms of strata :—

+ Bowbrig or Tourha' Coal.
+ Crawford or Major ,,
+ Five-quarter ,,
+ Parrot ,,
+ Turf ,,
+ Wee ,,

The last three seem to unite to form the "Main Coal" of Kilmarnock and Hurlford. In the centre of the field there are some lower seams, known by the names of Ladyha', Little Parrot, Gipsy, and Lower Main Coals. Then, underlying these Coal Measures, but overlying the Carboniferous limestone series, there occurs in Ayrshire a well-marked and extensive sheet or zone of igneous rock, forming the well-known basalt in the neighbourhood of Blair House, near Dalry, and extending southwards to beyond Kilmarnock.

Now, in walking from Kilwinning to Stevenston and Saltcoats we approach the north-western edge of this coalfield; and at Saltcoats, on the eastern side of the rocky point on which the harbour is built, and the once picturesque ruins of the old Saltpans and Magnesia Works stand, we find a remarkable succession of stratified beds cropping up towards and leaning upon the trap. There are numerous beds of shale, sandstone, and coal alternately—some 30 or 40 distinct beds in all—the softer parts being more worn, and the harder parts projecting line after line, like successive waves of the sea, or like the leaves of a half-opened book. This is the outcrop of the Coal Measures along the shore; and on careful examination all the seams marked + above have been identified, though in some parts a good deal effaced by the sea, and perhaps also by the digging operations of man.

The point at Saltcoats divides into two parts, known locally as

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the "inner and outer nebbocks." The "inner" is the one we first come to. Between the two, in the little bay which forms the harbour, we find a number of beds of shale and volcanic ash, occupying the place, apparently, of some of the lower seams of coal. Then we come to the "outer nebbock," which is really farther up the channel, and should more properly be called the "inner" one; and on its northern face we find a considerable seam of coal (probably the Lower Main) altered in a very remarkable manner, and rendered columnar by the action of the adjacent igneous rock. The strata then disappear under the detritus of the shore; but a little farther across the bay, about halfway towards Ardrossan, we come upon another series of beds projecting above the sand, and having the same general dip as all those we have already examined, viz., to the south-east. One of these is a bed of limestone. It is, in fact, the upper or "Linn" limestone, which in the Dalry field occurs about 17 fathoms below the basalt rocks of Blair Park, etc. The trappean point at Saltcoats thus appears to be the north-western edge of that great sheet of igneous rock which, as we have said, over a large part of Ayrshire forms the well-marked boundary between the Carboniferous limestone series and the overlying coal-measures. Our walk northwards has now brought us down to the Carboniferous limestone series. We break off a piece of the limestone (which seems to have suffered severely from previous hammerers) and find it charged with fragments of characteristic fossils. A little piece satisfies us, as there is not much of it visible here, and we like always to leave a remnant to our successors.

Coming to Ardrossan we observe on the eastern side of the point, immediately under the parish church, another striking succession of strata exposed in precisely the same manner as those at Saltcoats. Numerous beds of sandstone, shale, and ironstone crop up one after another in beautiful order, so that we can walk across them and compare them one with another as we go. One of the beds of ironstone has been identified with the famous "black-band" of Dalry, and, close to the trap, the main or lower limestone has been found, near the bottom of the series.

The point at Ardrossan is formed of a considerable mass of trap, rising behind into the "Castle-hill," where the structure of the rock has been very well disclosed by recent excavations for the extension of the railway station. It consists of beds of volcanic

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ash, agglomerate, and a coarse melaphyre or porphyrite which here and there assumes a columnar form—the columns at one place being bent or curved, in some degree like those of the famed "Clam-shell Cave" of Staffa. From its position between the Carboniferous limestone and Calciferous sandstone series, this trappean point is evidently the continuation of that great mass of interbedded igneous rock which, in a similar position, bulks so largely in the West of Scotland, forming the Campsie, Kilpatrick, and Lochwinnoch ranges of hills.*

Immediately to the north of the Castle-rock, we are on the Calciferous sandstone, in which a quarry was at one time wrought near the end of Montgomery Drive, and another not far from the new school-house is still, or was till lately, in operation. It is a good building stone, resembling that quarried in similar positions near Dumbarton and Gourock, and has furnished the material for erecting a great part of the town.

Proceeding northward towards Seamill, we pass two or three picturesque little glens wrought in the sandstone by the "burns" descending from the neighbouring uplands. In these the strata are well exposed, showing the mottled appearance and occasional beds of impure nodular limestone characteristic of the upper members of the series. The strata dip at a low angle to the S.E. all the way along the shore to Ardneil Point, near Portincross, to which we shall immediately refer.

There is thus presented to us at this part of the coast, within the space of two or three miles, a good deal of geological interest —an epitome, we may say, of the geology of Ayrshire, and indeed of a great part of the West of Scotland. At Saltcoats we have the outcrop of numerous seams of coal found in the neighbouring coalfields; then the zone of igneous rocks which in Ayrshire divides the Coal Measures from the Carboniferous limestone series. Then, in the short space between Saltcoats and Ardrossan, we have the Carboniferous limestone itself, represented by the Linn limestone, the blackband ironstone, and the lower or Howrat limestone. Lastly, at Ardrossan, we come upon the narrow continuation of the traps of the Kilpatrick and Renfrewshire hills, and the Calciferous sandstone series immediately beyond these.

* For information regarding the old castle, churchyard, &c., of Ardrossan, and the antiquities of the district generally, see a neat little volume entitled *Ardrossan, Saltcoats, and Neighbourhood: Notes, Historical and Descriptive*," published by Arthur Guthrie, Ardrossan.



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From Ardrossan to Ardneil Point, the strata, as we have said, are not much disturbed, dipping at a low angle to the S.E., and with but few of those interesting trap dykes which are so numerous at other parts of the coast. At Ardneil, however, there is more than one large dyke, and a very remarkable disturbance of the strata. Perhaps the best point to begin our observations in regard to this point is at West Kilbride. Close to the station there we see that the railway cuts through a large trap dyke, which crosses the line nearly at right angles. Going up the hill by the finely situated ruins of Law Castle, we can trace this dyke rising into a ridge of considerable elevation, extending eastwards towards the prominent hill of Knockgeorgan. Turning in the opposite direction, we find what appears to be the same dyke in the channel of the burn that flows through the village. On the western side of the village there is a large whinstone quarry which has evidently been wrought for a long time, still in the line of the same dyke. The trap continues with us in the form of a conspicuous ridge (in the side of which we notice a smaller quarry has at one time been wrought) down to the junction of our road with the Ardrossan and Fairlie main road, at Crosshill, where it is cut off and disappears under the old coast-line. We now pass on to Ardneil Point. Here, first of all, on the eastern side, we see the strata very much disturbed and disrupted, with great changes of dip within a few yards—in one place assuming a nearly vertical position and in another having the dip actually reversed. We then come upon a large dyke of trap, with which, however, the disturbance of the strata does not seem to be immediately connected, as it runs nearly at right angles to the line of that disturbance, and the strata on either side maintain what appears to be their old uniform dip independently of it. But it has produced a marked effect on the texture of the sandstone, altering it for some distance on both sides, and converting the nearer parts of it into a hard dark quartzite. The dyke has broken up by the action of the sea into large blocks, which are strewn about along the shore. It runs out westwards in the direction of the Little Cumbrae and Garroch-head. Looking eastward, we see it is exactly in the same line as the ridge at Crosshill, and the old castle, and the higher ridge beyond; and appears, in short, to be the same dyke as we had met with at all these points.

Leaving it as it plunges seaward, we next come upon a singular

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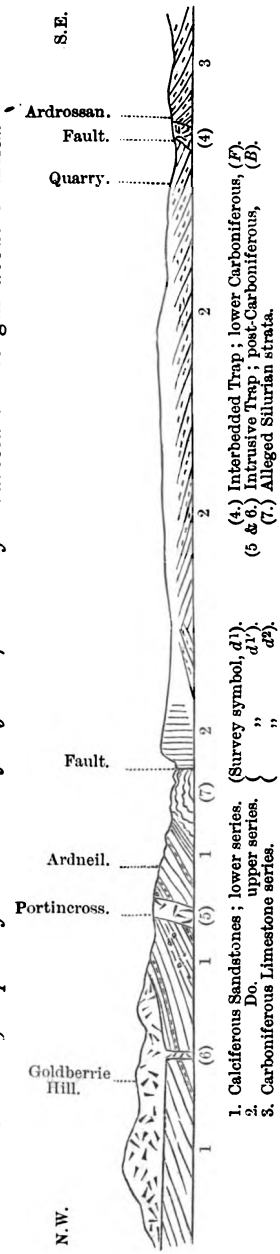


*Section of a part of the Coast of Ayrshire, North of Ardrossan. Length about 5 miles.*

break or chasm in the strata, running, not like the dyke from E. to W., but diagonally across the outcrop of the beds from N.E. to S.W. This break or chasm is about 50 yards in breadth. On the southern or Ardrossan side the sandstones dip S.E.; on the other side the dip is changed to N.W. The space referred to is occupied by a mass of curiously contorted shales of variegated colour, streaked with veins of calcspar, and intersected by one or two small dykes of claystone porphyry—the whole presenting a very extraordinary and puzzling appearance.

In 1858, the late Mr. J. Carrick Moore, whose observations on the Silurian strata of Ayrshire and Wigtonshire were frequently referred to by Sir Roderick Murchison, wrote a paper on this part of Ayrshire, which he communicated to the Geological Society, and which appeared in their *Quarterly Journal* for 1859. The main object of the paper was to call attention to what the author deemed to be "a protrusion of Silurian rock" at this point of the coast. Annexed is a copy of the section with which the paper was illustrated, but we have rearranged the numbers, and altered the descriptive notes. It may be taken as on the whole correct (with the exception, we think, of "No. 7," the alleged "Silurian strata" referred to).

We may also subjoin a passage from the paper, descriptive of the strata in question:—

"To the north of the trap at

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Ardrossan begin the red sandstones, also dipping S.E., but at a lower angle. The top beds are of a marly nature; and it is only near the bottom of the section that the strata contains a few pebbles of white quartz. For four miles the shore is composed of the same formation, still dipping S.E., until we reach a point where the beds, for a short distance, dip N.W. at a low angle. A little further to the north, near the house of Ardneil, the sandstones are vertical for several yards; after which we arrive at a spot where a sudden change in the rock, attended with the greatest disturbance, is exhibited. A mass of light and dark-green, claret-coloured, and black shales and arenaceous schists, veined with calcspar, and contorted in every conceivable way, has here been forced up through the sandstones and conglomerates, which to the south of the disturbance are pitched up to a high angle, while to the north they are elevated to about an angle of 50°. The breadth of the intruded mass is about fifty yards, and I think it is impossible for any geologist acquainted with the aspect of the Silurian rocks in the south of Ayrshire to doubt that this is of Silurian age. In mineral constitution, in cleavage, in variety of colour, in the violence they have been subjected to, they exactly resemble Silurian rocks, and in all these respects they present the strongest contrast to the Devonian* rocks with which they are in contact."

We believe the opinion thus expressed has not been borne out by subsequent investigation. The mass of variously-coloured shale which Mr. Moore here describes, and to which we have already alluded, though at first sight it presents a general resemblance to Silurian strata, is seen on closer examination to be widely different from these old schistose rocks. In these the laminæ, however contorted, can be traced quite distinctly. Here there are no distinct continuous laminæ, nor anything that can properly be called "cleavage." It is rather like a quantity of volcanic mud which has welled up, or been poured forth in a confused manner, and hardened along irregular lines and fissures, into which there has been a subsequent infiltration of carbonate of lime. There are difficulties of another kind in the way of accepting the conclusion now under notice. If this were really a "protrusion" of Silurian strata, it would in all likelihood be attended with a far greater disturbance of the strata than we see here. When we try to

* Now held to be Lower Carboniferous.

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realize the enormous dislocation required to bring up the Silurians amid the lower Carboniferous strata (or to throw down the latter against the former), we feel ourselves compelled to admit that the disturbance of the strata here, notable though it be, is far too feeble and limited to correspond with such a result. But it is perhaps unnecessary to argue against a conclusion which we understand has been definitely abandoned.*

On the other or northern side of the fault which we have been describing the sandstone is distinctly different in appearance—darker in colour, and much harder in texture; and the dip, as we have said, is changed to the N.W. It is evident there is here a great break in the series, bringing together strata separated by a considerable interval in time, and that we are now on much lower beds than those we have been traversing since we left Ardrossan. The disturbance appears to be greatest on the southern or Ardrossan side of the fault, indicating, we think, that there has been a down-throw on that side, attended with considerable crushing and fracturing of the strata. The appearances also lead us to conclude that this took place prior to the eruption of the large dyke referred to.†

A little further on, the old castle of Portincross stands out close to the sea, in the most prominent position furnished by this rocky

* The late Professor Nicol, of Aberdeen, in his well-known Geological Map of Scotland, published in 1858, founding evidently on Mr. Carrick Moore's paper, marked a "Silurian axis" on the coast to the north of Ardrossan. In the explanatory note to the map the Professor expressly alludes to "the axis of these [Silurian] rocks recently discovered by John C. Moore, Esq., north of Ardrossan." About three years afterwards, however (in 1861), Murchison and Geikie's "First Sketch of a New Geological Map of Scotland" appeared, in which there is no note of this alleged "Silurian axis," though it is quite a point that Sir Roderick would have held to had it been tenable. Again, in 1867, the fourth edition of Sir Roderick's "Siluria" was published, which, though it contains several references of a friendly and complimentary nature to Mr. Moore and his researches in the Silurian strata, is entirely silent respecting this alleged protrusion of the strata at Ardneil. We conclude, therefore, that it had been tacitly acknowledged to be a mistake.

† This dyke is no doubt one of the "Miocene" dykes which intersect the country in such numbers, and, like many of them, seems to occupy the line of a previously-existing fracture. Those great sinkings of the crust by which the Coal-Measures were "let down" into the hollows or basins they now occupy, had taken place—partly, at least—long before the Miocene period.

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part of the coast, and commands a fine view up and down the Firth. In olden times this was an occasional residence of the Scottish kings when on their way to Dundonald, in Kyle, or Rothesay, in Bute. It is mainly built of the red sandstone of the locality, with an occasional stone of trap, also gathered from the shore, and faced with a lighter coloured sandstone, got, no doubt, further to the east. The lime has stood remarkably well, and we can see has been skilfully mixed with broken sea-shells.

Turning northward round the point, and passing the well-sheltered house of the proprietor, Mr. Crawford of Auchenames, we come to another conspicuous trap dyke running east and west, through a gap in which the farm road passes, and continues for a short distance further on. The top of this dyke furnishes an admirable point of view, commanding the Cumbraes, Fairlie Road, the Argyllshire mountains away to the north and west; and, in the immediate foreground, a beautiful strip of lonely shore overlooked by the high cliffs of Ardneil Point. A little further on we come to a very coarse conglomerate, about 100 yards in breadth, consisting mainly of rounded pebbles of quartz—pink quartz in greatest abundance—some of them of unusual size. Many of these pebbles present a crushed and fractured appearance, similar to what has been observed in the Old Red conglomerate at Aberfoyle; and from the position in which some of them are found, it may be concluded that the appearance in question is due not to any surface pressure, but to a powerful compression acting in certain lines on the whole mass throughout. The conglomerate is succeeded by strata dipping more gently N.W., and these are surmounted, over the old coast-line, by a thick bed of red porphyritic trap, forming the high cliffs of Ardneil Point or Goldberrie Head, by far the most striking piece of coast scenery in the district. The sandstone along the shore is much broken and honeycombed by the waves, and is intersected by several trap dykes running east and west, which are seen in the face of the cliff to be connected with the superincumbent mass of trap. The cliff is beautifully wooded at the base, but a little higher up the trees and bushes dwindle away and give place to ivy and lichens—a great wave of vegetation dashing against the cliff, and throwing its spray, so to speak, far up towards the summit.*

* "Next, southward, lies the promontory of Portincross, which is terminated by the celebrated precipice called Ardniel Bank in some old writings

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We do not pursue our way further in this direction at present, but ascend to the top of the old coast-line, alongside of the trap dyke immediately to the north of Auchenames. The top of the hill here has evidently been an old fort; and a number of such hill-forts are found along this part of the coast, as at Boydston, Glenbuck, Seamill, and this hill of Ardneil. Some of these have been explored, and rude weapons and ornaments have been found, together with shells of edible mollusca and bones of several species of animals.*

We have as yet said nothing of the *boulders* of the district. A great many are, of course, of the porphyrites and other trap rocks, so largely developed in the neighbourhood of Portincross and the Cumbraes. Also, many of the fine conglomerate with white quartz pebbles from Kames Hill, above Fairlie, once largely used for mill-stones; and a good sprinkling of West Highland rocks—schists, quartzites, and granites. If we walk on to Ardrossan, we shall pass the "Boydstone boulder," about two miles N.W. of the town, the largest boulder on this shore. It is a mass of porphyrite rising out of the sand near low-water mark, and inclined to one side like part of a leaning tower. It is about 19 feet in length and breadth, and its highest point 9½ feet above the shore. The tide at high water leaves only 2 or 3 feet of it visible. A local poet has been inspired by this boulder to the production of the

*Goldberrie Head.* This majestic wall of rock, rising where highest to perhaps little less than 300 feet perpendicularly, ranges in a straight line along the water's edge, from which it is merely separated by a narrow slip of green land; and extends to about a mile in length. Along the bottom the precipice is richly fringed with natural coppice, in which the oak, ash, hazel, and hawthorn are thickly interwoven; upwards the glossy ivy is widely spread; whilst grey lichens, intermixed with large patches of a bright golden colour, succeed, lining the bold front to its utmost verge. Viewed from the plain below, the effect is highly impressive and sublime, whilst to approach its terrific summit the vivid description by Shakespeare of the cliff of Dover is fully realized. The general mass of these stupendous rocks consists of dark red sandstone, lying horizontally, but for a considerable space where highest the sandstone about midway up is surmounted by a beautiful brown porphyry. This portion, dividing itself into three distinct and deeply separated cliffs of equal height and uniform appearance, has immemorially obtained the poetical cognomen of the *Three Sisters*, otherwise *Three Jeans*, perhaps *Nuns*."—*New Stat. Acct. of Scot.*

* See *Trans. of the Archæological Society of Ayr and Galloway.*

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following lines (though we think it quite evident the stone is not so far travelled as he supposed) :—

"Stranger! whence didst thou come
To this shore?
Art thou an arctic crumb
Which of yore,
On some huge iceberg side,
From thy first home did glide,
A wanderer on the tide,
To this shore?

"Many eyes with wonder,
Ages gone,
Looked on thee; what number
Yet unknown
Will gaze with curious eye,
Seeking to know thy history,
And solve thy hidden mystery,
Old grey stone!" *

Here end our notes on this interesting district, which we heartily commend to the future attention of members of this Society.

## No. XXXVI.—Notes on the Spherulite Rock of Corriegills and the Banded Pitchstone of Invercloy, Arran. By David Corse Glen, F.G.S., and John Young, F.G.S., *V.P.*

[Read 14th February, 1884.]

During the Glasgow Fair Holidays of this last year, we took advantage one day of the well-known steamer "Ivanhoe" calling at Rothesay on her trip to Arran to have a sail along the eastern coast of that island as far as Whiting Bay, being prepared to stay at Brodick over the night if we found that accommodation could be had at the hotel, which is generally very full of visitors at this time. Learning on our return from Whiting Bay that we could have rooms, we landed, and shortly afterwards, bags on back and hammers in hand, we set off to the Corriegills shore to explore the Pitchstone and Spherulite veins found in that neighbourhood. The day had been fine, and the evening gave promise of settled weather,

* See Third Report of Boulder Committee.—*Proc. Roy. Soc. Edin.*, 1876.

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so we enjoyed very much our walk southwards along the coast, noticing by the way the most interesting of the geological phenomena recorded in the guide books, in the way of numerous trap dykes which there traverse the red Carboniferous sandstone strata, and also the boulders of Arran granite that strew the shore, one of which, the celebrated Corriegills boulder, from its size forms a conspicuous object on the beach. On arriving at our destination, and having passed the first Pitchstone vein, or that on the shore nearest to Brodick, we set ourselves to look out for the vein of Spherulite, which we knew existed on this tract of the coast, and at a point before we should arrive at the second or larger Pitchstone vein, seen on the beach a little further to the south, and which forms so conspicuous a bed in the sandstone cliff near the shore. Fortunately it was low tide, and long reaches of the shore rocks were uncovered, so we had not sought long ere we found traces of the Spherulite, and afterwards the vein itself, cropping out amongst the sandstone rocks near high-water mark, the vein from its position being often passed by without being observed.

In Dr. Bryce's "Arran" (fourth edition), pp. 75-77, these two veins of Pitchstone are shortly described, and at p. 76 we have his remarks on the Spherulite vein, with a description of the rock taken from Dr. MacCulloch's "Western Islands of Scotland," vol. 2, p. 405. Dr. Bryce, in the first place, says—"Between the two veins of Pitchstone which we have just described there occurs upon the flat shore another large vein of claystone, and which is remarkable for a peculiar structure. This is developed in those parts only which are near the junction with the sandstone, along the south side of the vein. The appearances are fully and accurately described by Dr. MacCulloch." Here follows MacCulloch's description of the Spherulite, in which he says that "The structure is concretionary, globular, or striated, the latter being either found separate or united with the globular in the same specimen. The former puts on sometimes the appearance of spots, circular or elliptic, resembling Siberian jasper. The spots, as well as the stripes, are attended with corresponding differences of hardness, the former arising from the globular structure, the latter from a schistose or laminar one. The spots being often elliptical, compressed, or elongated, occasionally become laminæ in the progress of elongation, passing into them by insensible degrees. The vein next the sandstone varies much in hardness, but it cannot be

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said that this induration bears any relation to its proximity to the sandstone. The concretionary structure is seen both in the hard and soft varieties; it is radiated fibrous, the radii sometimes diverging from a point and sometimes from a solid nucleus, which is further, in some instances, surrounded by a white earthy crust. In the progress of induration the rock at length loses its character entirely, appearing to pass into a substance of an indefinable nature, of a horny aspect and dark dull green colour, partaking of the character both of chalcedony and pitchstone. It has been described as a globular pitchstone, but it is far removed from this rock by its extreme toughness, want of lustre, and by the form of its fracture." Dr. Bryce concludes MacCulloch's description by stating that "mineralogists have long regarded this curious rock with much interest, and various opinions have been held respecting its true relations, some considering it as allied to claystone and others to pitchstone." In Ramsay's "Arran," 1841, this Spherulite rock is not noticed, although he refers to the pitchstones, and quotes MacCulloch's description of the larger vein on the Corriegills shore. Since the period when Dr. MacCulloch wrote his description, and even since Bryce's "Arran" appeared, much more light has been shed upon the structure of Spherulite and its chemical composition, than that formerly known. We now know that it is a true igneous product, being derived from the devitrification during cooling of a glassy sanidine lava. Sanidine is a glassy felspar of the orthoclase group, but with a higher percentage of soda in its composition than is found in the more typical varieties of orthoclase. A variety of the Corriegills Spherulite approaches in character that of perlite or pearlstone, which is another igneous product with a kind of pearly lustre, and having sometimes a spherulitic structure. It is probable that pearlstone is only the result of a further devitrification of the rock than that seen in Spherulite, as the two are closely allied in chemical composition. We here give the analyses of pitchstone, pearlstone, and Spherulite, from a table in Prof. Dana's Mineralogy, p. 360, ed. 1874.

| | $\ddot{Si}$ | $\dddot{Al}$ | $\dddot{Fe}$ | $\dot{Ca}$ | $\dot{Mg}$. | $\dot{Na}$ $\dot{K}$ | |
|---|---|---|---|---|---|---|---|
| Pitchstone (Arran) . | 63·50 | 12·74 | $\dot{Fe}$ 3·80 | 4.46 | — | 6·22 | ign. 8.0 = 98·71 |
| Pearlstone (Hungary) | 79·12 | 12·00 | 2.45 | — | 1·10 | 3·58 | H 1·76 = 100·01 |
| Spherulite (Hungary) | 77·20 | 12.47 | 2·27 | 3·34 | 0.73 | 4·27 | = 100·28 |

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It will be seen from the above analyses that the Spherulite differs from the Pitchstone chiefly in its containing a greater amount of silica. This seems to alter the character of the rock, making it much tougher and more difficult to fracture, as well as altering its lustre, as already stated by MacCulloch. The spherulitic structure, as seen in our specimens, seems to be due to the arrangement of the mineral elements, while they were still in the glassy or vitreous condition, around nuclei or centres, and as the cooling went on the spheres were gradually enlarged in ring-like or zonal layers, from their centres outwards, until they often touched each other; and if they advanced beyond this point in size the spheres became polygonal in form, from mutual pressure on each other while they were still in the plastic state. In those spheres which do not touch each other, the interspaces are often seen to be filled with a brownish kind of granular mineral matter, which looks as if it had been rejected or squeezed out as an impurity from the spheres in the cooling of the rock. In the spheres which have become polygonal through pressure, transparent sections show that although their walls are in actual contact, yet there is a clearly defined line between each sphere, beyond which the radiated structure noticed by MacCulloch does not extend. This internal radiated structure of the spheres is quite visible to the eye with a pocket lens in fractured specimens, but is better seen in transparent sections under a low power of the microscope.

Spherulitic structure is believed to have been not uncommon in certain of the older glassy, acid, lavas of the felspar group, in which now the structure is obliterated through subsequent crystallization or other alteration of the rock; yet in some of these it is sometimes developed by weathering, much in the same way as that observed on the surface of some of our limestone rocks in which remains of organisms are to be seen, while in the unweathered interior of the stone none are observable. Prof. Judd, in his paper on the "Secondary Rocks of Scotland" (*Quart. Jour. Geol. Society*, Aug. 1874), refers to this interesting fact in the following words, p. 280—"That the geologist never meets with glassy lavas (obsidians, pitchstones, &c.) among the older rocks will not occasion much surprise when we reflect upon the facility with which artificial glasses undergo devitrification. That glassy lavas were formed even in palæozoic times appears to be indicated

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by the fact recorded in the text that weathering sometimes reveals the characteristic *spherulitic* structure in some of the lavas of Lorne."

In our short examination of the bed on the Corriegills shore we found several varieties of the Spherulite, these varieties no doubt being due to differences in the rate of cooling, as well as differences in the amount of devitrification which has taken place. The variety best suited for sectioning for microscopic examination is that of a dark-greenish grey colour, and in which the spheres are not in any way decomposed at their centres. Those in which the centre of the spheres are of a chalky white colour and texture look pretty in rough specimens, but owing to their softness they come out as holes in the polishing. We obtained some specimens in which the spheres on the outer surface of the rock are clustered together in a botryoidal form; but specimens showing this structure are rare. We also noticed that both the Pitchstone and Spherulite beds on this portion of the coast are to be considered intrusive sheets or veins of igneous rock matter, rather than dykes—that is, they have been injected amongst the sandstone strata along weak lines of resistance. Sometimes these veins are conformable to the bedding of the sandstone, but in other places, where weak lines existed, they are seen to traverse the strata obliquely. This fact is noted in all the geological guide-books, as well as that Pitchstone in vertical dykes is to be found in other parts of Arran, and is seen to cut through all kinds of rock from the granite upwards, and is now generally regarded as being of Miocene age. Dr. Bryce ("Arran," p. 155) describes another spherulitic rock as occurring in Moneadh-mor glen, and as presenting "a close analogy with the spherulitic claystone of Corriegills; but the radiated structure of the latter," he states, "does not exist here." But he is wrong in saying (p. 77) that "the radiations of the Spherulite are of pure quartz, while the base is of the same substance but mixed with colouring matter, iron or manganese, and other trifling impurities," as shown to the contrary in the foregoing analyses by Prof. Dana. There can be no doubt whatever that the fluid magma out of which it was formed was highly oxidic, silica being the most abundant ingredient, but rocks of this class, formed out of such a magma, as represented by obsidian, pitchstone, pearlstone, and Spherulite, when thoroughly devitrified show the presence of alumina, and

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resolve themselves into claystones or felstones, which no pure quartz materials will do.

After having obtained as many specimens of the Spherulite rock, as well as of the two Pitchstone veins, as we could carry away, we ascended the steep hillside at Corriegills with our heavy loads until we came to the old Lamlash road, where we halted for a short time to regain our breathing and have a look at the magnificent scenery by which we were surrounded. We reached Brodick hotel about 10 o'clock P.M., just as daylight was beginning to fail, well pleased with our afternoon and evening's work.

On the forenoon of the next day we visited the tract of Pitchstone that is to be seen near the new school-house beyond Invercloy, and by the side of Brodick wood. Dr. Bryce ("Arran," p. 51) describes it as a vein, or perhaps bed of Pitchstone in the sandstone, the colour being bottle-green, with red specks of felspar disseminated in the base, giving the rock a porphyritic texture approaching that of Pitchstone-porphyry. He says it is probably a continuation of one of the many beds or veins of the Corriegills shore, and has a breadth or width exposed of fully thirty yards; but it is very difficult to say whether it is a bed or vein. We are inclined to think that it is an intrusive sheet like that of Corriegills, as it seems to lie conformable in a measure to the dip of the sandstone strata, which here rise to the north-east. This sheet of Pitchstone is well worthy of an examination by geologists who may happen to visit this portion of the Arran coast, and as may be seen from the specimens we exhibit it is of a somewhat different character and texture from that found at Corriegills. If the surface of some of the large weathered blocks be examined they will be found to present a banded appearance, the bands varying slightly in colour and being sometimes about half an inch in breadth, as shown by one of the specimens on the table. If such a banded specimen be examined in a fresh fracture of the rock it will be seen that it is due to alternations of vitreous with less vitreous layers of the Pitchstone, and it is in the less vitreous portions that the specks of felspar, noticed by Dr. Bryce, are most abundant. These evidently have been segregated while the rock was cooling, and it seems to us as very probable that the banded structure has been caused by some slight separation of the mineral elements along what have been termed fluxion lines, and while the lava was still flowing; the bands having an appearance like that seen

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in some of the blocks of vitreous slag from our iron furnaces. Altogether this Pitchstone is more slag-like than any of the others we obtained.

Leaving our specimens at the smithy on the roadside, and still having a couple of hours or more before us ere the return to Brodick of the "Ivanhoe," by which we intended to go back to Rothesay, we had a short run up Glen Rosa, as far as enabled us to get a good view of the hills that close in the head of the glen, and the mounds of moraine matter that lie along its sides near its lower reaches. We then returned to the smithy, shouldered our specimens, and were back at the hotel in time to partake of an excellent early dinner before the steamer arrived on its homeward run from Whiting Bay. After another pleasant sail we were safely landed at Craigmore pier in Rothesay, very highly gratified with our short Arran trip and with the interesting specimens we had obtained.

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## No. XXXVII.—The Silurian Rocks of the Girvan District. By David Forsyth, M.A., B.Sc., *V.P.* With Two Sketch Maps and Sections, [Plates XIV. and XV.]

[Read 13th March, 1884.]

### I.—General Configuration of the District.

In the southern corner of the triangular county of Ayr there is a district so markedly distinct in general featuring from the rest of the county that the early inhabitants, ever ready to notice such physical differences and to give them apposite names, had designated the district by the characteristic name of Carrick. In journeying southwards the traveller remarks at once the difference in scenery. Leaving the town of Ayr he begins to enter a more undulating country than the somewhat monotonous flats of the plain of Ayrshire from Dalry to the banks of the Doon. On the horizon he sees to the east and south higher elevations, and if he travel south of the Girvan valley he soon reaches a land of hills and moorlands, as desolate and bleak as any district of broad Scotland. In fact, this portion of the county is a portion of the great ridge of elevated ground which stretches across the country from Loch Ryan to St.

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Abbs Head in the general direction from S.W. to N.E. The great southern uplands are in fact another "Highlands," not so high, not so grand, nor wild; yet rivalling the northern Highlands in lone barrenness, in savage ruggedness, and even in some spots, as at Loch Trool, in picturesqueness. The hills are softer in outline than the Bens of the north, but many of them rise, like Merrick, nearly to 3,000 feet. The valleys are generally narrow, with gently sloping banks, dotted with homesteads, surrounded by a portion of agricultural ground—the holms, the meadows, or "infields"—but small in comparison with the extent of pastoral ground attached to each. It is the peaceful retiredness of these which lend such a charm to the scenery, and it is in such homes that the lonely fisher, or wearied geologist, finds his heartiest welcome.

As the best instance of this kind of valley I may cite the Stinchar valley—one to which I shall have to allude several times in this paper. The Water of Stinchar runs through Silurian rocks throughout its whole length, and the valley presents, therefore, especially in its upper and middle portions, a monotony of feature which characterizes so many upland valleys in the south of Scotland. But in its lower course, where the erupted and much altered Ballantrae rocks give variety to the scenery, and where woodland and cultivated ground alternate, there is no more beautiful example of Scottish river scenery, not even "bonnie Doon" itself.

The Girvan valley partakes of a much more varied character. Leaving the southern hills not far from the Stinchar it flows like most "well-behaved" rivers, at right angles to the ridge of elevation. After passing Straiton it turns and flows nearly parallel to the general direction of the elevated lands from N.E. to S.W. Passing also through Silurian, Old Red Sandstone, and Carboniferous strata, its scenery varies as much as its course. In its lower portion the valley is much broader than that of the Stinchar, the land is well wooded in many places, and in others highly cultivated. Bounded on both sides by hills, the valley is saved from tameness; and from the summits, in the words employed in describing the district by one of our most eloquent geologists—Hugh Miller—"the eye glances adown a noble valley bosky with green woods, and chequered with smiling fields, and marks where it opens to the broad Atlantic a busy seaport town, or rests far beyond on the dim

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cloudlike Ailsa." The hills on the S.E. side of the lower valley—Hadyard, Saugh, Brae, Fauldribban—rise gently on their eastern sides, but towards the west descend abruptly to the valley, their steep sides looking like escarpments. This, as I shall afterwards point out on the sectional map, is due to two causes, the occurrence of faults and the inclination of the strata. As in other rivers whose course is along the "strike" of the strata, the Girvan does not give many good sections, but this want is amply compensated by the variety of the sections seen on the tributary streams, which crossing the strata more or less at right angles, cut deeply into the rocks. Thus in the Lady Glen are seen good sections of the Carboniferous rocks of the districts; while the Kilkerran, Bargany, and Penwhapple burns give ample opportunities of studying the position and relations of the Old Red and Silurian strata.

Large boulders are found all over the district, even near the tops of the hills. These are generally of grey granite, and one in the grounds of Killochan Castle is of huge size, and has been described by Professor Geikie.* These boulders can be traced backwards to their original home—the granite district near Loch Doon and Loch Dee. Till is exposed in many of the tributary valleys, and in the railway cuttings, especially near Glendoune. River gravels and clays are found of considerable thickness, and a deposit of Post-tertiary clays was laid bare a year ago by dredging in the Girvan harbour; while similar beds are worked at Dippool, to the north of Girvan. See the author's paper, *antea*, p. 251.

Geologically considered the lower portion of the Girvan valley consists of Carboniferous and Old Red Sandstone strata, bounded to the N.W. by a smaller, and to the S.E. by a very much larger Silurian area. The Carboniferous rocks are evidently an extension of these of the Ayrshire coalfield, like those of Muirkirk and Dalmellington, preserved from denudation by their presence in the valleys. Coal is worked at Bargany, Kilgrammie, near Dailly station, Dalquharn, and Kilkerran, and a Carboniferous limestone used to be worked at Lannielane.

The sudden change from Carboniferous to Silurian strata is readily noticed on both sides of the valley. In leaving Dailly station, near which is a coal-pit in active operation, the geologist finds himself after a walk of less than half a mile among Silurian shales and flagstones. Such a rapid transition is sure evidence of

* "Geological Sketches at Home and Abroad," Lond., 1882.

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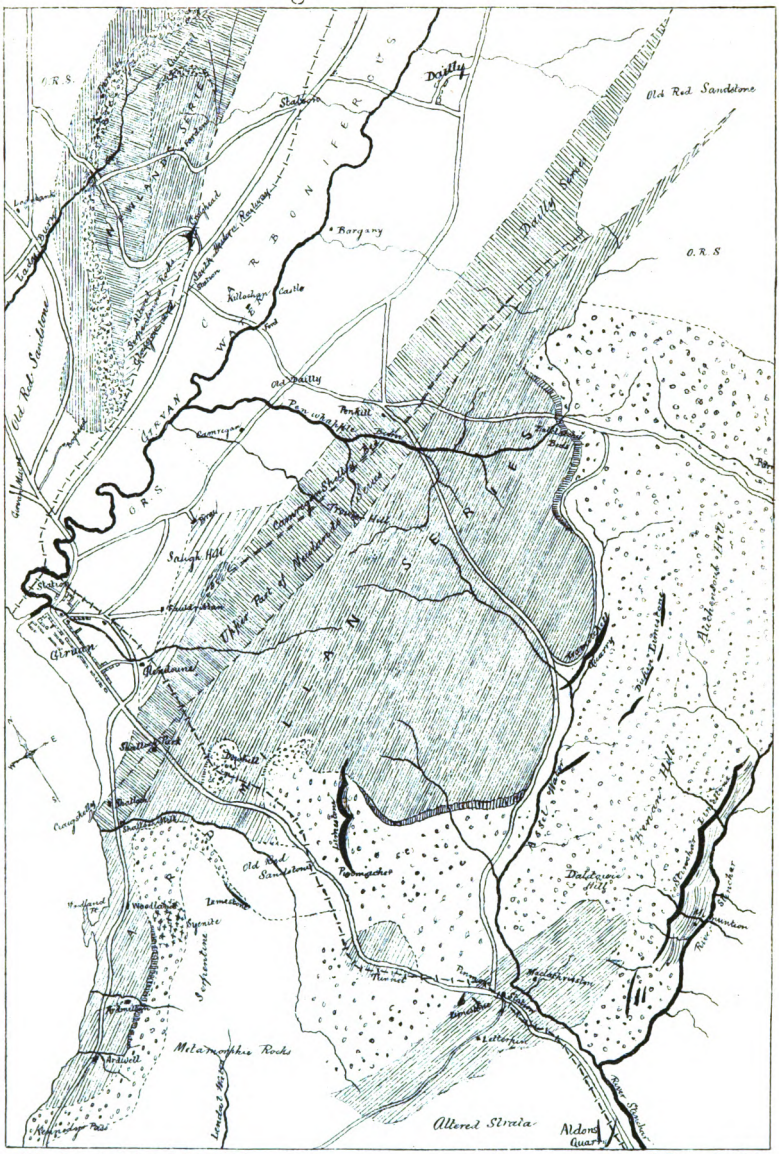
# Sketch Map of the Girvan District.

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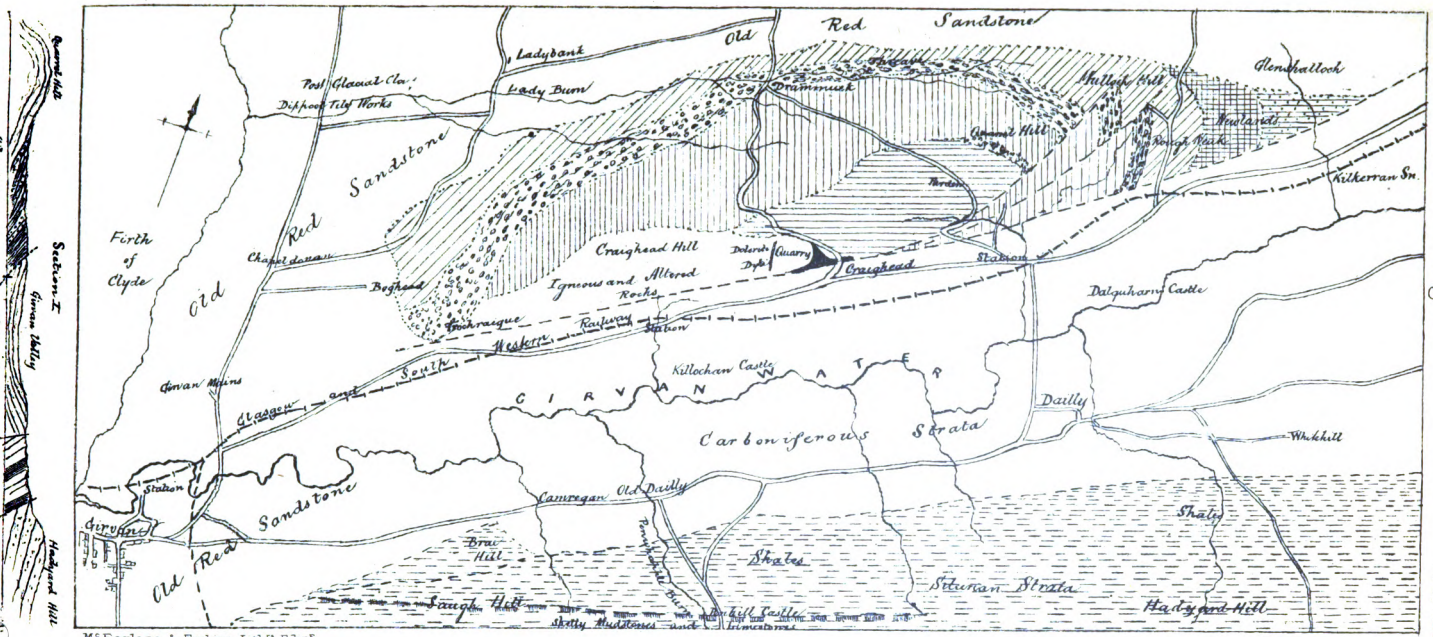
# Sketch Map of the Craighead and Mulloch District.

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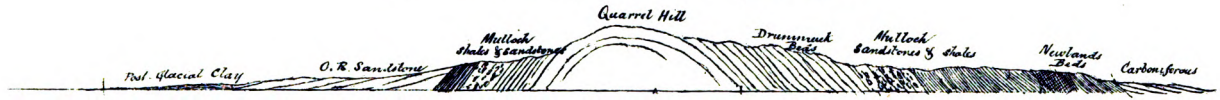
D. Forsyth, del.




Diagrammatic Section from N.W. to S.E. of the Anticline

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a large fault; and I shall point out on the map the fault known as the Craighead fault—extending along the S.E. face of the Silurian hills—Craighead, Quarrel, Mulloch. A similar fault extends along the S.E. side of the valley, along the N.E. side of the hills that bound the valley on that side, from the shore at Shalloch to the south of Bargany, and on to Straiton.

The influence of these faults on the relation of the strata are indicated by the rough sections (excluding details) which I have sketched. The first is from Quarrel Hill to Hadyard Hill; the second, from Quarrel Hill to Stinchar; the third is from the north of Craighead Hill to Saugh Hill; the fourth is from the town of Girvan to Pinwherry. For greater distinctness the scale of elevation is exaggerated in proportion to the horizontal scale. [See Plates XIV. and XV.]

These faults are accompanied by smaller faults. For instance, the great southern fault divides into—

(1) One up Piedmont Glen.
(2) One between Saugh and Brae Hills.
(3) The main fault, sending down the Carboniferous against the Silurian.

A more extensive fault runs along the S.E. side—therefore another strike fault—of the Stinchar Water, by which the limestones of that district are thrown against the graywackes of the southern uplands. This fault runs from the neighbourhood of Pinmore Bridge by Pinm re Mains to Pinclanty, and on to the neighbourhood of the quaint village of Barr.

It is this extraordinary faulting and consequent dislocation that makes the district so difficult to understand. And yet, strange to say, it has been by the careful mapping out of the faults, accompanied by as careful a study of the palæontological evidence of the dislocated strata, that has led to their complete arrangement in methodical succession. Dr. Lapworth has disentangled what to the physical geologist was a confused succession of limestones in detached masses, shales differing from and resembling each other, and conglomerates occurring in most tantalizing relations to them all.

Out of the apparent confusion he has succeeded in bringing method and arrangement, and that by no statement of theoretical conceptions, but by deductions made from thoroughly accurate and severely exacting field-work. Somewhat sceptical of his conclusions



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at first, after many discussions over maps and plans, I went with him two summers ago to verify some of his sketches, and to be shown practically the reasons upon which he based his "Girvan succession." I shall take you to the same district and series of sections, and feel confident of the same result as on that warm summer day we clambered the hills between Assel and Stinchar—complete conviction—complete, because based upon visible evidence, verified by section after section.

Between the Assel and Stinchar stretches a ridge of high ground gradually towards Barr—the hills of Daldowie, Benan, Auchensoul. Rushing down the N.E. and S.E. slopes of this ridge are many tributary burns all cutting the strike of the strata at right angles. On the ridge the most striking feature is the persistence of a conglomerate along the top, of a grey-greenish tint. This conglomerate is continuous over the district on the opposite side of the Assel towards the shore of Girvan—being well seen at Kennedy's Pass on the top of the Ardmillan Hills, Byne Hill, Dowhill. With the keen eye of the practical geologist Dr. Lapworth seized on this well-marked feature, mapped its dislocations, and established its relations to other strata.

From section IV. you will see that the ridge is covered with this conglomerate; going downwards to the Stinchar valley along the Benan Burn are shales with Graptolites, then a compact limestone—worked at Minuntion for agricultural purposes. In the splintery whitish-orange shales above it I found fragments of Trilobites. This compact limestone is visible in thick faces all along the side of the hills; below it are found splintery and shaly limestones, with shells, particularly *Orthis confinis*—these are succeeded by red and grey sandstones—and these again by another conglomerate, purple in colour. It is most interesting to observe how the line of compact limestone (and of course the other strata) follows the contour of the country—running up the little valleys of the burns, and abutting on the Stinchar valley along the faces of the intervening ridges.

A section exposed by the Kirkland Burn confirms the arrangement. Wherever, therefore, this Benan or green conglomerate occurs one expects to find part or the whole of this succession.

On the opposite side of the ridge, from faulting, the evidence is somewhat obscure, but the relation of the conglomerate to the compact limestone at Dupin at least is clearly made out. This

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limestone is again seen at Pinmacher and Tramitchell, and always in the same relation to the conglomerate.

It is along a low undulation N.W. from this that the relation of this "key" conglomerate to the series above it is seen. These are the Balcletchie Beds—reddish and bluish-grey-coloured clay-beds, and are highly fossiliferous. In them are readily obtained Trilobites (*Olenus*, *Encrinurus*, *Ampyx*,) *Theca*, *Lingula*, the oddly-shaped *Turrilepas Scotica*, and a few Graptolites. Quite near, but further down the burn, is a shelly conglomerate in which are found occasionally very perfect specimens of *Leptæna*, *Bellerophon*, and *Strophomena*, with a few Corals.

The section from the bridge downwards is exceedingly interesting and instructive, as the succession of shales, conglomerates, and flags is clearly seen on both sides of the burn, and also on the side of the road. The next series is best seen on the face of the hills behind Ardmillan House, and along the shore between Ardwell and Woodland. By a fault running up Piedmont Glen the succession from Balcletchie is interrupted. But in the Ardmillan area the succession is quite regular. Next to the conglomerate occur—

(1) A series of beds identical in physical appearance with the Balcletchie strata, and with the same fossils, and in the same state of beautiful preservation. They are seen in any of the sheep drains down the side of the hill, and in small scaurs made by the sheep rubbing, but in no large exposures.

(2) Ardwell beds—a series of graptolitic shales and flagstones.

(3) Barren flagstones—a series well marked and most annoying to the palæontologist, who hunts in vain for the faintest trace of a fossil among their greenish-grey fissile shales and flags.

(4) At Woodland Point a fault occurs which, while it interrupts the succession, is very apparent, and I may add very encouraging, because it throws down against these trying barren flags a small portion of limestone belonging to a higher group, and abounding in magnificent specimens of Corals (especially *Halysites* and *Favosites*), *Pentamerus*, *Strophomena*, and other shells. This patch is very small and is below high-water, and was discovered accidentally by me while pottering along the beach, and you can

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imagine my joy at capturing a magnificent specimen of *Halysites catenulatus*—now in Mrs. Gray's collection—from what before to me had been a most dissatisfying district.

The true successor of those barren flags is found, however, in the district north of the Girvan valley—in the Mulloch Hill conglomerate—of which I shall have occasion to speak more fully hereafter.

The next series is that termed by Dr. Lapworth the Newlands series—

(1) Mulloch Hill conglomerate.
(2) Mulloch Hill sandstones and limestones (shelly).
(3) Saugh Hill group.
(4) Camregan limestone.

Regarding the first two I shall again have occasion to speak. The evidence of the relation of the Saugh Hill group is not conclusive, as the sections are few, and not specially characteristic, while there is also an interlacing and interlapping of beds that must indicate great flexure and possibly several secondary faults. Near the old hill road I found in gritty sandstones a few very fine specimens of Graptolites.

The next series lies between the villages of Dailly and Straiton, and comprises—

(1) Penkill group of grey and red shales, in which are found *Crossopodia* and Graptolites.
(2) Blackwood Beds with a few Graptolites.
(3) Drumyork flags, Blair shales, with *Beyrichia*, *Chondrites*, *Orthonota*—more like the Muirkirk and Lesmahagow strata.
(4) Straiton grits, in which I have found no fossils.

Such completes the plan of succession proposed by Dr. Lapworth. Judging from the care bestowed on its preparation, and from the frequent opportunities I have had of examining the sections, I feel certain that time and future investigations may supplement it, or work it out in more detail, but that as a scheme of arrangement it is complete. And, above all, it is valuable as being based upon examination of the district by careful stratigraphical, palæontological, and physical methods.

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## II.—Detailed Description of the Silurian Area to the North of the Girvan Valley—embracing Craighead, Drummuck, and Mulloch Hill Districts.

This portion of the Girvan Silurian system extends in a lenticular mass from S.W. to N.E. in a line parallel with the valley. It is faulted against Carboniferous strata towards the south and south-east, and is covered to the north by Old Red Sandstone rocks. The dome-like, or anticlinal nature of this area was first indicated by Murchison. The axis of the dome is rather to the south of the central line of the greatest length of the areas, and the strata to the south slope more abruptly than those to the north. Denudation has bared the summit of this anticline, having exposed there the lowest (or rather the lowest visible) strata of this district; and the higher strata are arranged round this central boss in circling zones—their continuity sometimes disturbed by faults, but these not of such a violent nature as to prevent the ready recognition of the plan of the district.

In describing this district I shall in imagination take you from Dailly station to High Mains, and leaving our heavy materials in the picturesquely situated quarry of Rough Neuk, ask you to clamber to the summit of Quarrel Hill. Here, after pausing for a short time to admire the beautiful prospect extending from Ailsa Craig to Dalmellington, and to recover breath after the steep ascent, the general lie of the country can at once be seen. Beneath you are the Carboniferous strata, evidenced by the chimneys of the Dalquharn pit, while you are actually standing on the barren flagstones. A few exposures are sufficient to show you the character of the rocks, and as you will meet with them again later in the journey they may be dismissed without further notice. Even after years of search, I have been rewarded only by a few Graptolites—*Diplograptus*(?)—and a rod-like fossil, resembling an encrinital stem externally, but all the specimens badly preserved, and very rarely met with.

Coming down hill by an easier declivity, you reach an exposure of a conglomerate, or rather of a flagstone with pebbles embedded in the blue muddy matrix. In this are found a few fossils—shells usually—particularly *Orthis calligramma*, *Leptæna sericea*, and *Strophomena grandis*. These are succeeded by shales and mudstones, abounding moderately in fossils; and these in capital

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preservation, generally Brachiopoda and Trilobites. These have been named the *Trinucleus* beds. The exposures are best seen afterwards in the Lady Burn. The *Trinucleus* beds are succeeded by the Mulloch Hill sandstones and mudstones, which consist first of a conglomerate, dark red in colour, abounding in casts. This conglomerate is a marked feature of the district, circling round the Silurian area nearly the whole way from W. to N.E. Dark grey muddy sandstones follow next, and are well exposed in the Rough Neuk quarry, where the green grass and young trees form a favourite resting-place for luncheon, and where the fissile sandstones yield an extraordinary number and variety of fossils.

In one of the drawers I show a selection characteristic of this favourite fossil-hunting spot—*Orthis reversa*, *Strophomena expansa*, *Atrypa hemisphærica*, *Rhynchonella cuneata*, *Murchisonia* (casts), *Trochus helicites*, *Conularia Sowerbyi*, *Nidulites favus*, *Heliolites interstricta*, *Streptelasma* and many other Corals, *Phacops* (fragments). Passing on along the winding road towards the Kirk Hill, the roadside gives frequent exposures of yellowish and reddish rocks. In these, too, fossils are abundant, but very badly preserved, being often only casts of an orange-yellow soft earthy matter. Yet these are to be remembered as the "golden hued" fossils so lovingly spoken of by Hugh Miller; and which placed against the neighbouring dark red rock as a background form such striking specimens.

These yellow and red rocks are succeeded by gritty sandstones with Trilobites and *Pentamerus*. Some of the best specimens exhibited I found in an old "dry stane dyke," in a plantation near at hand. Many of the fossils are casts, however; although the fragments of *Ilænus* exhibited are the largest I have obtained in the district.

And last of all come the blue shales to the S.E. of Newlands, in which I have found only a few badly preserved Graptolites; although the sections are numerous in a small burn traversing a wood to the eastwards.

This forms the highest portion of the Silurian strata of this district. And, as I have said before, its successors have to be looked for across the valley between Dailly and Straiton.

Wheeling round back to the round above Rough Neuk, we cross the fields, and find in the Lady Burn the Mulloch Hill conglomerate with its characteristic shells and casts; and then a series of exposures

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of Drummuck beds. In these grey-blue rocks Brachiopoda and Trilobites are found in fine preservation.

The rock is hard at first, but if left for a day or two on the banks of the stream it splits readily, and exposes fossils in much finer condition than if one were to "hammer" it at once, for the action of weathering reveals the natural cracks of the rock, and, if not allowed to go too far, shivers round the specimen. The spots I have found most productive are—

(1) Twenty yards below the point where the Mulloch conglomerate crosses the stream. Trilobites, *Theca*, *Conularia*, *Bellerophon*, and *Murchisonia* are found here in good preservation.

(2) One hundred yards further down, below a fence crossing the burn. Here, in addition to large specimens of *Bellerophon bilobatus* and *B. acutus*, are found good specimens of Trilobites often curled up.

(3.) Above Thraive farm, and at the footbridge near it. Here I have obtained good specimens of *Trinucleus seticornis*, and *Proetus latifrons*.

(4) Below Thraive farm. Trilobites—especially *Calymene Blumenbachii*, of large size, but generally casts.

(5.) Near Drummuck very few specimens have been got of late years, although those found are beautifully preserved.

The tenant of Drummuck shows readily to geologists the large and beautifully preserved specimens found many years ago, and they seem to incite the collector to greater vigilance in the hope of matching such splendid remains. In the large drawer I show specimens which will give you some notion of the variety and number of specimens to be found in this area.

Leaving Drummuck we pass over the barren flagstones and come down on Craighead. This is a most interesting spot, first from the abundance of fossils, especially Corals, and second from the enigmatical nature of its relation to other rocks. It is the abundance and variety of its fossils that mark it off from any other limestone in the district. Among the dark-coloured soft shales between the two quarries are found *Orthis*, *Leptæna*, *Strophomena*, Echinoderm plates, Encrinital stems, Trilobites—the compact limestones of both quarries being marked by abundance of Corals.

In the West quarry, *Heliolites favosus*, *Lyopora favosa*, *Prosopora Grayæ*, *Lindströmia subduplicata*.

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In the East quarry, *Favosites Girvanensis, Tetradium Peachii, Zaphrentis turbinata, Streptelasma Craigense.*

For the cutting and polishing of the beautiful sections of corals exhibited to-night, I am indebted to Dr. Hunter, of Braidwood.

The lessee, Mr. Caldwell, has been in the habit of laying aside all good specimens, and is lavish with his "finds" to any wandering geologist, while he is as hospitable as obliging. Craighead Hill is composed of altered or metamorphosed rock—serpentinous—and this adds another difficulty to the placing of it in its correct position. Dr. Lapworth thinks, however, that the calcareous conglomerates to the west represent the basal conglomerate of the Stinchar and Assel areas, and that, therefore, the Craighead limestone is a representative of the compact limestone of the Minuntion and Benan districts.

With all my respect for Dr. Lapworth and his arrangement of the Girvan strata, I cannot think that the correct position of this enigmatical limestone has been proved. The differences in the fossils are so marked, and the faulting so cuts off all means of getting petrological relations, that I am afraid the Craighead limestone must remain an outstanding exception from the general arrangement.

To the west of the quarry is an interesting ravine, a whinstone dyke, dug out for road metal. As the quarrymen have followed its sinuous path they have laid bare a winding chasm, clad round by creeping plants and overhanging shrubs, that forms a unique geological exhibition of the nature and action of igneous rock on older strata.

Such is but an outline of one ot the most interesting parts of one of the most interesting geological areas in the south of Scotland. It is classic ground, for Sedgwick, Murchison, Miller, Lyell, Wyville Thomson, Geikie, Young, Mrs. Gray, Lapworth, Nicholson, Etheridge, have all in turn visited, admired, puzzled their brains over it; and races yet of enthusiastic geologists will come to its peaceful burns and gently sloping hills to see for themselves what the very priests and kings of the science have described. Might I throw out the suggestion to this Society that a day could not be better spent than over the Mulloch, Drummuck, and Craighead districts, and that in that time more could be said, and more seen, and I believe more genuine pleasure experienced,

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than I could hope to give you here with all the accessories of maps, sections, and fossils.

"Ah! that such beauty, varying in the light
Of living nature, cannot be portrayed
By words, nor by pencil's silent skill,
But is the property of him alone
Who hath beheld it, noted it with care,
And in his mind recorded it with love."

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## No. XXXVIII.—Note on *Favosites* (?) (*Calamopora*) *Dentifera*, Phillips. By John Young, F.G.S., *V.P.*

[Read 6th December, 1883.]

Prof. Phillips, in his description of the fossils from the Carboniferous limestone of Yorkshire and the North of England, published in 1836, briefly describes (at pp. 200, 201) six species of *Calamopora*, one of which, found at Bolland, he names *C. dentifera*, (Pl. I. figs. 58-60), and gives it the following characters—"Incrusting, apertures of the cells with spicular edges."

Phillips' species of *Calamopora* have all now been removed to other genera, Prof. Morris placing *C. dentifera* amongst the *Favosites* in his Catalogue of British fossils. Milne Edwards and Haime, in their Monograph of Carboniferous Corals for the Palæontographical Society, while referring to Carboniferous *Favosites*, express doubts as to *Favosites dentifera* (Phillips) really belonging to that genus, and state (p. 153)—"But in the present state of palæontological science cannot be characterised." The rough figures which Phillips gives show an incrusting organism, forming a thin patch about three-fourths of an inch in diameter, with numerous small, round-mouthed cells, the walls of which are spinose or toothed.

For several years a somewhat similar organism, which forms thin crusts upon shells, stems of crinoids, the spines of *Archæocidaris* and *Productus*, has been known to me as occurring in the Carboniferous limestone strata of the West of Scotland. In this organism the cells are mostly of a polygonal form, having thin walls, which in young and unworn specimens are denticulated,

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there being a short tubular spine generally placed at each angle of the cell, with sometimes smaller tubercular spines between. In tangential sections of the cells, polished at right angles to their surface, it is seen that these spines form small pores in the walls, thus agreeing in character with those seen in the walls of many of the *Monticuliporidæ*. Recent examinations of my specimens, as well as of some finely preserved examples from the limestones of the North of England, sent me by Mr. James Bennie, of the Geological Survey, strongly incline me to the belief that the *Calamopora dentifera* (Phillips) is only the young incrusting stage of some species of *Monticulipora*, which is closely allied to, if not identical with, Ure's "Millepore," an organism which I brought before this Society last session (see p. 264), and in which I find that, in its youngest or first incrusting stage, its walls are often strongly denticulated, or spinose, but as it gets older these spines are reduced to tubercles, and its cells become filled with the perforated tabulæ so characteristic of Ure's "Millepore." I do not know if the type specimen of *C. dentifera* (Phillips) is still in existence, but if so, and if I am right in my conjectures, I think it will be found that it is only the younger stage of some *Monticulipora*, which, in its older stage, has probably been described under some other name, as I have shown to be the case in that of another organism of the *Monticulipora* group—the *Ceramopora* (*Berenicea*) *megastoma*, (M'Coy), being the young incrusting stage of *Fistulipora minor* of the same palæontologist. (*Annals and Magazine of Natural History*, December, 1882.) [See page 244 of the present volume.]

## No. XXXIX.—Review of the Southern Silurian Question. By Arthur Macconochie, Collector to the Geological Survey of Scotland.

[Read 10th April, 1884.]

### [Summary.]

The author remarked at the outset it might safely be asserted that, at present, only two readings of the order of succession among the complicated rocks of the Southern Uplands claimed the attention of geologists, namely—that adopted, after careful and detailed

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mapping, by the officers of the Geological Survey, and that of Prof. Lapworth, to whose splendid work among the Silurian rocks of the Moffat and Girvan areas attention was more particularly directed, giving first a brief recapitulation of the chief points in the Moffat paper—how the Moffat black shales are subdivided into Lower, Middle, and Upper, or into "Glenkilns," "Hartfells," and "Birkhills." The lowest, or "Glenkilns," yields in abundance a large variety of Graptolites, to which the genera *Cœnograptus*, *Didymograptus* and *Thamnograptus* are peculiar; while the species *Dicranograptus ziczac*, *D. formosus*, and *Dicellograptus divaricatus* appear to have an equally restricted range in that district. Next the "Hartfells," the lower half of which is made up almost entirely of black anthracitic shales charged every here and there with a profusion of Graptolites, *Dicellograptus*, *Pleurograptus*, *Amphigraptus*, and *Diplograptus* being the commonest forms. The upper half of the "Hartfells" is made up of some 50 to 100 feet of greyish and grecnish shales, the well-known "Barren Mudstones," which yield few Graptolites. One or two genera only Prof. Lapworth found to pass up into the succeeding Birkhill division, the fauna of which differs very markedly from the Glenkiln-Hartfells. Simple, single forms, which to the uninitiated look as if there had been a universal break up of the preceding branching types, now reign supreme. And yet there is no evidence of any physical break in the sequence. Indeed, it is apparent even to the most casual observer that the conditions of sea-bottom in the Moffat area must have remained almost uniform during the deposition of the few hundred feet of soft black shales, mudstones, &c., which make up the Moffat black shale series. To the Glenkilns Prof. Lapworth assigns an Upper Llandeilo age, while the Hartfells are supposed to be the dwarfed representatives of the Caradoc, and the Birkhills the Lower Llandovery. And since he maintains that "they rise invariably from below the graywackes in anticlinal form . . . and are the oldest rock group in the Moffat district," the graywackes and shales of the Southern Uplands must consequently be of later date, or, as he says, "generally speaking of Llandovery age," and since all the Glenkiln-Hartfell Graptolites are said to have died out before they reached the Birkhills, they cannot reappear in overlying beds. But many years ago Mr. Carrick Moore announced the occurrence of *Dicranograptus*, &c., in the flaggy graywackes of

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Cairn Ryan, and in sandy shales along the Corsewall shore, while *Cœnograptus gracilis*, and other characteristic Glenkiln-Hartfell graptolites, are not of uncommon occurrence in the shaly partings of the graywackes south of the Stinchar valley. Yet it is upon the graptolitic evidence, and reliance upon their restricted range, that the richly fossiliferous Girvan rocks are correlated with the Moffat black shale series. Beginning with the lowest or Barr series, which yield *Didymograptus superstes*, *Dicellograptus sextans*, &c., they are considered the equivalents of the Glenkilns, and consequently of Llandeilo age. In like manner the "Ardmillan series," with a few Hartfell forms of Caradoc age, and the "Newlands series," with its Birkhill Graptolites of Llandovery age—while the "Dailly series" modestly absorbs all the Queensberrys Ardwells, Kikcudbright Wenlock shales, &c., though the strip of Silurian rocks forming this latter series, we are told, "rarely exceeds half a mile in breadth, and throughout much of its extent is less than one-fourth." And yet the beds lying almost side by side with the Girvan rocks, viz., those on the south side of the Stinchar fault, while yielding in plenty, as at Carsphairn and Craiglure, the Glenkiln-Hartfell Graptolites do not contain a single other fossil of the rich fauna of the "Barr" and "Ardmillan" series, nor have they a single lithological peculiarity in common. Nevertheless, as these beds appear equally well adapted for the entombment and preservation of organic remains, the entire absence of such appears utterly inexplicable upon the supposition that they are contemporaneous. In conclusion, it appeared to the author that, while admitting there may be some anomalies in the Survey reading, these seemed to him insignificant when compared with the difficulties and contradictions to which the adoption of Professor Lapworth's views would commit us.

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## No. XL. — The Silurian Districts of Leadhills and Wanlockhead, and their Early and Recent Mining History. By John R. S. Hunter, D.Sc., LL.D., F.R.Ph.S.E., *Hon. Mem.*

[Read 29th May, 1884.]

Leadhills, the seat of an extensive mining industry, is situated in the parish of Crawford, in the southern extremity of Lanarkshire, adjacent to the sources of the Glengonnar Water, on the mountain road leading from Upper Nithsdale to Upper Strathclyde. It is about 2 miles distant from Wanlockhead, about 44 miles S.E. by S. from Glasgow, and 46 miles S.W. by S. from Edinburgh. Its site has an elevation of at least 1300 feet above sea-level, and is possibly the highest inhabited land in Scotland. The village lies on the side of a valley; some of the houses being in rather a low position, one position being named the High Toun and the other the How Toun. The appearance of the neighbouring country is of the most sterile character, hill above hill showing only scanty herbage or heather. The miners have, however, reclaimed about 300 acres, and grow crops of potatoes and hay, corn not ripening here, and the green patches show in pleasing contrast to the otherwise bleak and barren country above. The outlook is magnificent: in a clear day can be seen on the north the Pentlands, on the south the Solway Firth, the Isle of Man, the Cumberland Hills, on the west Ailsa Craig, the Arran Peaks, the Paps of Jura, and Ben Lomond.

The parish of Crawford is very hilly, and was aptly designated a portion of the Southern Highlands by Heron, the friend and admirer of Robert Burns. According to Forrest's map of the county, published in 1816, its area is 118¼ square miles, or 60,183 Scots acres. The boundary line of the county runs for the greater part along the watershed which divides the basin of the Clyde from the rivers flowing through the neighbouring counties. Many of the higher hills are only partly in Lanarkshire. They may be classed as follows:—1st. A great portion of the ground between the Avon and the Douglas is 1000 feet above sea-level; on the boundary line are Goodbush Hill, 1556 feet; Priesthill Heights, 1615 feet; and Nutberry Hill, 1712 feet. 2nd. The district between the Douglas and the Elvan is moss, moorland,

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and hill, a large area being 1000 feet in height, except near the Clyde and some tracts on the Douglas and Duneaton Waters. The chief heights along the boundary are Cairntable, 1944 feet; Stoneyhill, 1843 feet; and Wanlock Dod, 1808 feet. Many other hills reach a height of from 1500 to 1800 feet. Tinto rises to 2335 feet. 3rd. A triangular mass of hills in the extreme between the Elvan and Clydesburn having, along the boundary, Lowther Hill, 2377 feet; Queensberry Hill, 2285 feet; and this is the most southerly point in the county. The Lowther Hills belong to a range running 7 miles N.E. and S.W. between the Elvan and the Powtrail, of which Green Lowther Hill attains the altitude of 2403 feet. Between Clydesburn and the Mouse the ground rises rapidly from the Clyde. On the boundary are Hillshawhead, 2141 feet; Coulter Fell, 2330 feet; and others nearly as high.

An old rhyme of the district runs as follows:—

> Tweed, Annan, and Clyde
> Sprang frae ae hillside;
> Tweed ran, Annan wan,
> Clyde fell an' brack its back o'er Corra Linn.

This is nearly correct—the sources of all these streams not being far from each other. The Annan flows southwards to the Solway Firth, a distance of nearly 30 miles; the Tweed goes by Tweedsmuir and Drumelzier, and then eastwards, having a course of nearly 100 miles; the Clyde takes a north-westerly direction till, below Greenock, it expands into the Firth of the name, a distance of over 100 miles. For 20 miles from its source, it winds and wimples around green hills without trees, covered for the most part with grass and heather, but in some places deep moss hags with their treacherous "walle'es." The river is formed by the junction of the Dair and Powtrail Waters with the Clyde Burn, a few miles above Elvanfoot, where also the Elvan Water meets the others. In some of the valleys of this upland district vast quantities of alluvial drift are strewn about. Great banks have been formed along the foot of the hillsides, with stretches of meadow land below. There is a lower valley cut out by the action of the river, with haughs in its windings presenting here and there steep gravel banks. Near Crawford the Clyde is joined by the Midloch and Camp Waters, and a little above the village of Abington the

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Glengonnar flows into it. Near Roberton, between Abington and Lamington, the Clyde passes from the Silurian rocks to the Old Red Sandstones, and the country begins to assume a more beautiful and cultivated aspect. Its course soon curves NE. round the base of Tinto Hill, which is composed of a mass of intrusive felstones rising through chocolate-coloured mudstones and conglomerates of the Lower Old Red period.

The strata dip here generally N.N.W., which shows the lowest beds. On the south side of the hill under which they lie, at angles varying from 20 to 50 degrees, at no great distance below might possibly be found the upper members of the Upper Silurian series. The Clyde there flows for several miles through a large, flat, mossy valley extending to Biggar. Here it is only separated from the Tweed by a narrow neck of land and a slight elevation, and the waters of the two meeting occasionally when in spate. By this means, doubtless, it is that salmon find their way to the upper reaches of Clyde, as, of course, they cannot pass the Falls below. The two rivers soon diverge, however, the Clyde flowing for some miles N.W., over Calciferous sandstones near Carstairs, where it is joined by the Medwyn. Running then to the S.W. it again finds the Old Red strata where the Douglas Water joins, and resumes its N.W. course, reaching after a time the famous "Falls of Clyde."

Near the village of Crawford or Crawford-Lindsay, which was erected into a Burgh of Barony between 1214 and 1249, stands the Castle of Crawford which tradition says that Sir William Wallace took by assault, putting the garrison of fifty English soldiers to the sword. In the adjoining parish of Lamington Wallace married Marion, daughter of Hugh de Bradfute, and from the daughter of this marriage the Baillies of Lamington claim descent.

Crawford-John parish and village have the distinction of being the only ones in Scotland called by a christian as well as a surname, and which were given to distinguish them from the adjoining parish of Crawford-Lindsay. When the Crawfords obtained the grant of Barony in the thirteenth century it was designated as Crawfordville de Johannes, which soon after was corrupted into the present title. This was a favourite locality of King James V. during his many hunting expeditions, and here was erected Boghouse, where he resided. It is said that a castle of considerable

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importance once stood near the village, and that its materials were used in the construction of Boghouse at the period when this parish and that of Crawford were annexed by the Crown. From ancient records it would appear that great entertainments were given here. At one of them, when the French ambassador spoke of the barrenness of the country, the king retorted that it could produce richer fruits than could be found in France, and a wager being made, he won it by having set before each guest at dessert a bowl with gold pieces made from the produce of the mines on Glengonnar and Elvan Waters. Various localities in the parish show traces of extensive workings for gold and other minerals.

Wanlockhead, a great seat of mining industry belonging to the Duke of Buccleuch, is situated on the N.E. boundary of the parish of Sanquhar, about two miles from Leadhills, and might be placed as in the same locality, for the mines of the two companies who now work both districts have their mines underground close to one another. The Wanlock, or Grey Glen, runs south-easterly from the Crawick stream for nearly four miles towards the Lowther Hills, the name evidently having regard to the dreary aspect of rock, bent, and heather which meet the eye on the hillsides. The Wanlock stream, though fed by numerous rills, has a grey, bluish-white tinge characteristic of its surroundings. The Wanlockhead smelting works convey the water in glazed pipes underground for several miles, as motive power for the various pumping engines used to drain the lower levels of the lead mines. Near the head of the stream, and at the base of the Dod Hill, lies the village of Wanlockhead, the houses consisting mostly of "a but and a ben."

The exploration for lead, gold, and other minerals at Leadhills and Wanlockhead has been carried on for a long period of time. There were once found in old surface workings in both places the tools used in excavating the lead ore, some of the picks being of stone and others of bronze, showing that these mines had been worked at a very early period of our history, probably in pre-Roman days. We know that the Romans worked lead mines in Britain, and as, besides many camps and stations, a Roman road traverses this district, it is more than probable that those of Crawford were among the number. Some time ago the workmen came across some old workings at the Strait Steps and Ellison Sole, situated near the Bay and the Dod at Wanlockhead. Here the lead veins were so narrow that the miners must have excavated

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their drifts nearly sideways—some of the main drifts being nearly 3 feet. The ore was brought out in narrow barrows with straps for the shoulders, and there was no more room in the drifts than just enough to allow them to pass. Tools of various descriptions were also here found. The Wanlockhead Company came upon some other old workings at West Glencrieff, which I inspected on 3rd May, 1884. About 7 fathoms from the surface there was a cross-cut of 6 feet high by 4 feet wide. The lead vein was very small, showing scarcely a trace of pure ore; but in another "random" or level I saw a very fine exposure of lead ore about 8 inches thick and widening out gradually. In these old workings I saw old pumps and other machinery lying in position, with a few of the tools used by the miners. I picked up two little iron wedges with a small hole in the centre of each for putting in a handle or attachment of some sort, to prevent them from being lost among the ore or rubbish of the drift.

The exploration and working for lead and gold in the districts of Wanlockhead and Leadhills are mentioned in records of an early date. The first allusion we find is in the grant of lands in Crawford Muir to the monks of Newbattle by Sir David Lindesay in A.D. 1239, where a mine on Glengonnar Water is mentioned. It had been sunk for lead, as appears from a suit raised before the Lord Auditors in Parliament at the instance of Patrick, Abbot of Newbattle, against James, Lord Hamilton, for the spoliation of 1000 stones of lead ore, which had been carried off from the Abbey lands in Friar or Crawford Muir, and Lord Hamilton was ordered to restore it again. Lead was sent from Crawford Muir to Rutherglen in A.D. 1263, as appears from an entry in the Exchequer Rolls of Scotland. In 1467 a charter of resignation granted by David, Earl of Crawford, included the "mines" and "leadpit." In the "Descriptio Regionum et Insularum Scotiæ," by Leslie, Bishop of Ross, it is stated that the gold mines of Crawford Muir were discovered in the reign of James IV., and Hector Boethius informs us that "In Clydesdale are the gold mines, and diamonds, rubies, and hyacinths, discovered in the reign of James IV." In the years 1511-12-13, a number of payments are entered as made to Sir James Pettigrew and the workmen employed in the old mines. The names of the various head workmen are recorded, viz.:—Sir Lebald Northberge, the



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master miner; Andrew Ireland, the finer; and Gerald Essemer (a Dutchman), the smelter.

After the defeat and death of the King at Flodden, the search for gold and other minerals was abandoned for a time, but was afterwards resumed by the Queen Regent; for we find in an account of James, Bishop of Moray, the Treasurer, in 1515—"Item, delivered to my Lord Postulate of the Yles for to pass to Crawford Mure, and thare to set workmen and mak ordinances for the gold myne to gud compt in ane hundrith crounes of wecht xxxx li. (40 lbs.)" From various papers preserved, it would appear that mining operations were continued profitably under the Regent Albany. In July, 1526, the King granted a lease to some Germans, but they did not search long, as we find that James V. resumed the grant and worked the mines for behoof of the Crown. After his marriage with Mary of Guise, mining operations here received a great impetus, as the Queen procured miners from France.

In the Treasurer's accounts for 1539-40 there is a charge for interpreters to pass with the French "mynours" till they learn the language, as well as for the subsistence of these "mynours." A grant was also made of "ane Scottish boy that speaks French to serve them till they get the Scottish language." In another record by the Treasurer, he mentions—"Item, deliverit to George Carmichael, son of the captane of Crawford, 3 ounces of gold, which he deliverit to the queen's grace the time she was in Crawfordjohn, price £6, 8s. the ounce." Large returns of gold were now obtained. The Book of the Royal Compoters is full of entries of payments and of the amounts of gold received. Amongst these the most interesting is that of the issue of gold of the mine in 1542 to form the Regalia of Scotland (now in Edinburgh Castle), viz., 35 ounces being devoted to the Queen's crown, and 3 lbs. 10 ounces to that of the King. In the same year 17 oz. were employed in making an eke or addition to the great "cheyne" belonging to the King, and 19½ oz. in forming a belt for the Queen, the workmanship costing £15. It was set with a sapphire, for which £5 was charged.

The great prosperity of the mines at this period is also testified by a curious MS. in the Cottonian collection, from which we learn that sometimes there were 300 men employed during the summer months, and that in three years a sum of upwards of £100,000 sterling was collected. This MS., so far as it can be made out, will be found at the end of this paper. I have thought it best to print it, as it not

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only affirms the "nuggetty" character of the gold diggings in the district, but coincides generally with what is known on the subject at the present day.

During the minority of Queen Mary and the regency of the Earl of Arran, the mines were neglected, but soon thereafter miners were brought from England; for the following entry appears in the Treasurer's books:—"For a copper kettle sent to the English miners at Crawford Mure, £3 1s., and also 7 stone of lead to fine gold with." It would appear from this that lead mining had been abandoned, or why otherwise would lead have been required to be sent? On 23rd January, 1562, a grant was given "To Johnne Achesoun and Johnne Aslowane, burges of Edinburgh," permitting them to "wirk and wyne in the lead mynes of Glengonnar and Wanlock," and to transport the ore to Flanders that the silver might be extracted, "paying to the Queen fourtie five unce of uter fyne silver for every thousand stane-wecht of lead." Another grant, dated 26th August, 1565, was for five years to John, Earl of Atholl, to "cause wyn fourty thousand trone stane-wecht of lead in the nether leid hoill of Glengonnar and Wanlock." In the Register of the Privy Council we find mention of an "acquittance to Johnne Achesoun, maister cunyiour to the Queen's majesty, and John Aslowane, burges of Edinburgh," dated 24th July, 1565, of the soume of ane thousand ane hundrith lxxxxvi. li., xi.s. x.d. ob. as for the full and compleit pryce of nyne hundreth unce of utter fyne silver."

During the minority of King James VI., a license was granted to Cornelius de Voss from London by the Regent Murray through the instrumentality of Queen Elizabeth. He procured a considerable amount of gold at Leadhills, and in the course of thirty days 8 lbs. weight of gold, worth about £450 sterling, was sent to the Mint in Edinburgh. As soon as Morton became Regent in 1572, C. de Voss returned to London and assigned his interest to Arnold Bronkhurst, who did not continue long in the adventure; for in 1583 the King, considering that the mines "have decayed by the non-putting of men of knowledge and judgement to the inventing and seiken of the samen," granted the "hail golden, silver, copper, tin, and leiden mynes within this realme of Scotland to Eustachius Roche, medicinar, and his partners, for the space of twenty-one years." This adventure also proved a failure, for by Act of Parliament, in 1592, it was rescinded. There were various exceptions to the grants to Roche, although it is distinctly stated he had the

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whole mines in the kingdom ; as we find, in the Leadhills district, by a contract recorded at Holyrood House, 17th February, 1575-6, between the King and the then Regent Morton on the one part, and Abraham Petiersoun, the Fleming, on the other, licensing the latter to work, for twelve years from that date, " all and sindry gold, silver, copper, and leid mynes and mynerallis quhatsumever in Scotland, reservand and exceptand the leid mynes of Glengonnar and Orknay presently laubourit be George Douglas of Parkhead, Capitane of the Castell of Edinburgh, Adam Fullertoun, burges of Edinburgh, and others." They were allowed to "extract, draw furth and fyne gold and silver out of the said copper as he best can ; providing always that the hail gold and silver sa fynit and extractit out of the copper be presentit to the Maister Cunyeor and sauld for the pryces foirsaidis, viz., the unce of gold at twenty twa carret fyne and ane half, for sextene poundis, and the unce of utter fyne silver for silver for xxx.s. usuale money of this realme without payment of any uther dewtie to our Soverane Lord thairfoir."

On the reversal of the attainder of George Douglas of Parkhead in Douglas Water, we find him applying his skill which he had acquired in the North of England to the metallic treasures of the district. He devoted some time in collecting gold in the valley of the Shortcleuch, where he was unfortunately killed. It is mentioned by a contemporary that George Douglas of Parkhead " was slaine with the fall of the braye after a great weite, and was found three days after that, and had good store of gold about him, and he was before always accounted a poor man ; but he was buried better than any of his kindred had been of long time before."

Thomas Foulis, goldsmith in Edinburgh, appears to have possessed mines at Leadhills, and to have been the most successful adventurer in the district. These mines have been worked by his successors to the present day. His privileges and rights are mentioned in the Act of 1592, and were specially exempted from that enactment. Amongst the Lansdowne MSS. there is preserved a letter from Gavin Smith, mining engineer to Lord Burghly, dated 1578, mentioning that two years previous Foulis had paid a visit to the North of England for the purpose of securing the services of some person skilled in mining operations, that he had first applied to Smith, but had finally entered into an agreement with Mr. Bevis Bulmer, who was, at the time the letter was

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written, engaged with Foulis in working a most profitable lead mine in Scotland. Bulmer was a person of some note in his day, as we find him mentioned in the Records of the City of London as an "ingenious gentleman." His early life was connected with mines in the North of England. When he first went to Leadhills he confined himself entirely to the search for lead, but the dazzling pursuit of the richer metals captivated him, as we find him procuring a patent from the Government to "adventure and search for gold and silver mines" at Leadhills. He was at first very successful, but his restless character led him on in search of other speculations. He returned to England and presented Queen Elizabeth with a porringer of Scottish gold with the following inscription :—

"I dare not give, nor yet present,
But render part of that's thy own ;
My mind and hart shall still invent
To seek out treasures yet unknown."

In 1587 we find him engaged in working the lead mines at Mendip in Somersetshire. About this time the silver lead mines at Combe-Martyn in Devonshire were discovered, and he became a partner in the lucrative speculation, each partner clearing £1000 per annum. After the accession of King James to the throne of England he was made a knight, afterwards returning to Leadhills and resuming mining operations. He died in 1610 at Alston Muir in Cumberland, and a house existed some years ago on which was recorded in rude rhyme that it was erected by Sir Bevis Bulmer—

"Who won much wealth and mickle honour
In Short Cleuch Water and Glengonnar."

Vast mounds of *débris* on the Elvan or Short Cleuch are still called the "Gowd Scars," and a row of houses in Wanlockhead is called the "Gowd Scar Row. Bulmer had a stamping mill erected at the head of Long Cleuch Burn, a tributary of the Short Cleuch.

George Bowes was another gold seeker of eminence. He held a commission from Queen Elizabeth. Scotland at this time was considered quite an Eldorado, and attracted crowds of English and German adventurers. It is recorded that Bowes was empowered to "dig and delve" as he would. At Wanlockhead he discovered a small vein of gold "which has much gold upon it." He swore his men to secresy, and after working the vein for some time he

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caused the shaft to be closed before returning to England with gold valued at seven score pounds. He never came back, having been killed by falling down a shaft.

Atkinson, the pupil of Bulmer, procured a license from the Privy Council of Scotland in 1616 to "search for gold, the Saxeer, the Calumeer, and the Salyneer stones in Crawford Mure." He did not succeed in his undertakings, and abandoned them. The mines were again let to John Hendlie, a physician, for twenty-one years, but he also failed, and the search for gold as an article of commerce was abandoned from this time. The miners at both Leadhills and Wanlockhead often search for it in their spare time, but it is most difficult to procure.

Some of the gold coins of Mary Stewart were the produce of gold mines in Linlithgowshire, as well as those of Leadhills and Wanlockhead, and during the reign of James V. the two latter places furnished the chief supply. It is stated that Charles I. had his coronation medal struck from gold of the same districts, which also supplied the material for the three-pound piece of James VI.

The extent of the gold field is about twenty-five miles from north to south, and about ten miles across, at least so far as is yet known. The localities are (1) Lesmahagow, (2) Leadhills, (3) Friar Moor on Glengonnar Water, (4) Short Cleuch Water, Long Cleuch Head, Crawford Moor, (5) Tempie Cleuch, (6) Minnoch Moor, Nithsdale, (7) Wanlockhead, (8) Wanlock Water or Glangersgill on Robert Moor, (9) Langham Water, (10) Meggat Water, (11) Phinland, (12) Alroyn, (13) Pontshields, Poneil, Lesmahagow, (14) Cumberhead, Lesmahagow, (15) Gold Scour, Elvanfoot, (16) Marksdale, (17) Cramyll, Crawick Water, (18) Glencleuch, Thrieplock House, Glencaple Burn, Elvan Water. The chief indications of gold looked for by the miners of the district are nearly the same now as they were 300 years ago, viz., "Keele and Spar," Keele being an earthy oxide of iron, while Spar is quartz.

The gold is found in alluvial detritus, as in various foreign gold regions, but it might possibly be procured in quantity from various ores of the district. What are commonly called gold ores are chiefly gold with iron pyrites or "gossan." Of the gold precipitated in metals, or amalgamated with them, a very extensive class of combinations exists. The metals, or ores of metals, from which gold has been obtained, are copper, lead, silver, iron, and zinc.

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Gold appears to have been obtained from copper ore in England at a very early period. The extraction of gold from lead ore is as ancient, and from these two sources have come the chief supplies of the precious metal during the middle ages.

The geological framework of southern Lanarkshire is mostly composed of Silurian rocks, succeeded by Old Red Sandstone and Carboniferous strata. The Silurian system is extensively displayed, the lower beds being exposed in various localities, while there is a remarkable development of the Upper Ludlow rocks. Both on lithological and palæontological grounds, we come to the conclusion that the Llandeilo and Caradoc beds are represented in the strata near Leadhills and its vicinity, while the Ludlow rocks are found on the Nethan and Logan Waters. The fossil-bearing strata are, however, few in number, and from their broken-up and contorted condition it is often impossible to say definitely to which group particular beds belong. The Lower Silurians are well represented in Lanarkshire. If we take a section from near Crawfordjohn across the Snar Water, Leadhills, and the Lowthers, to the valley of the Powtrail Water, we find there is a synclinal trough, the strata seen to the N.W. along the boundary fault being again brought to the surface on the S.E. side of the Powtrail Water, the beds being often repeated along the line of section. A fine section of the Llandeilo beds may be seen in a cutting of the Caledonian Railway at Crawford, and between it and Leadhills, separating the valleys of the Elvan and Glengonnar Waters, and the same rocks are found at various points from Cogshead, by the smelting mills at Wanlockhead, Leadhills, and Laggan Gill, near Abington, while the Caradoc strata extend from the Wedder Dod in a N.E. direction, passing towards the hills on the right bank of the Clyde below Abington.

The mining field of Leadhills extends over a number of square miles, but the principal workings are near the village. Although the mines have been wrought for centuries, it is only in a few veins that operations have been carried to any great depth. Within an area of about four miles there are upwards of forty veins, the majority running in a N.E. and S.W. direction, but often intersected by others with quite different bearings. The veins vary greatly in thickness, in some cases reaching a number of feet, in others coming down to an inch or two, and again quite wanting, while their contents are quite as various. In some

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galena alone is found, in others galena with sulphate of barytes and quartz, or again only sulphate of barytes, and decomposed Silurian rock. The place where the finest minerals have ever been found was in the Susannah mine, abandoned many years ago from lack of power to drain away the water, though the mines are to a certain extent drained by adit levels. There is in the "Braidwood Collection" from this famous vein magnificent specimens of carbonate of lead, phosphate of lead, sulphate of lead, sulphide of lead, Lanarkite or sulphato-carbonate of lead, Leadhillite or sulphato-tricarbonate of lead, Susannite (differing only in specific gravity), crocoisite or chromophosphate of lead, linarite or cupreous sulphate of lead, and vanadinite or vanadiate of lead. A list of minerals found in the districts of Wanlockhead and Leadhills is given at the end of this paper.

On the 2nd of May this year (1884) I paid a visit to the district for the purpose of bringing my information up to date, it being thirty-three years ago since I first went to Leadhills to obtain specimens. I arranged to go down one of the shafts 115 fathoms deep, the descent being made by strong ladders of beech-wood, of about 12 feet in length, and each placed on a small landing, on a different side from the one below. Some of these ladders are almost perpendicular, so that one must hold on pretty securely in case of a fall. About 44 fathoms from the surface we entered a large gallery where formerly an engine was placed to draw water and ore and other material to or from the surface. Proceeding downwards other 75 fathoms, we saw exposed a vein of lead ore, called locally "Brown's Vein," and of the average thickness of 5 feet. On the ledger side of the vein we found quartz of different varieties, about 9 inches thick, then lead ore of good quality, about 18 inches thick, then quartz 2 feet, with iron pyrites. "Nailhead" spar and other crystals are frequently seen. At the bottom of the shaft the roof is nearly 10 feet high, but slopes to an arch of about 7 feet. Two men are employed here filling the ore or the *débris* into kettles holding about 10 or 12 cwt. The *débris* often contains valuable crystals, but when seen at the bottom of the shaft it presents a most uninviting appearance. The 85-fathom level, where the lead ore had only been worked for about six months, is driven 6 feet in height and 4 feet wide. At the face on the ledger side or "country" as it is termed by the miners, the whole vein is nearly 4 feet wide, and is composed of

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strains of Silurian rock, the vein of lead ore being only about 4 inches thick, but at the middle of the face there are lesser veins of ore on either side. Calcite and barytes are both well represented. At the bottom of the sole of this level the lead vein alters, and is 12 to 15 inches thick. It is of extra good quality, and is believed to be argentiferous. In this vein is frequently got what is termed by the miners "steel" ore, which contains a good deal of sulphur, and is difficult to free out. On the "ledger" and "hanging" sides I saw that slickensides were very abundant. The veins of lead ore vary at every step, being sometimes remarkably rich, while at other times the levels are driven for many fathoms without anything of importance being met with.

Where the miners come upon a rich vein of lead ore cubical crystals of galena are sometimes found in perfection, and also where the vein begins to "die" or run out, but they are rare in the solid mass of the ore. The crystals of barytes are a sure indication that lead is at hand. Blende, "Black Jack," or the "Devil's Friend," as the miners term zinc ore, has no affinity to lead-bearing strata, and gives the miners great trouble in their explorations. It runs from 2 to 12 inches in thickness, and shows various forms of crystallization. Specimens of iron ore are frequently got, but the miners look upon it as unfavourable to the existence of lead ore. When cutting some of the main levels, and before lead makes its appearance, a length of from 30 to 40 fathoms is sometimes driven, the surrounding rock being of a close dried nature. Water percolates through what the men call "sandbars," or the places where crystals are formed, but after the water disappears lead ore makes its appearance. Often a knot of lead ore extends 20 or 30 fathoms, the "ledger wall" and "hanging side" then coming nearly together and forming what is termed a "check."

After a level is cut to the required distance the men come back with headings usually about 6 feet, and continue to the next level of from 12 to 20 fathoms. If it is wished to follow the "knot" further down, small pits are sunk, and similar operations to those above described are gone through. The "headings," or, as they are sometimes termed, "rise-holes" or "roosting," are built with oak timbers 4 feet long by 3 inches thick and 6 inches broad, placed every 6 feet, and are used for ventilating purposes, and for carrying away the lead ore. All the water goes to the "ledger" side or dip of the mine. Sometimes small accumulations of water

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contained in small chambers or cavities are come upon, and these often contain fine crystals. It is a most beautiful and charming sight to see one of these newly opened, the crystals flashing in the lamp light like the diamonds of fairyland. These openings have been known to extend to a length of 18 feet by 6 feet high, while others are only a few inches in extent.

At Ridge Shaft the Leadhills Company have erected powerful machinery which drives the crushing "jiggers" and "slime buddles," besides drawing the ore and other material out of the pit, which is about 45 fathoms deep. The crushing and sorting processes are very interesting, the raw material being supplied at one end and the pure ore, separated from all impurities, being delivered at the other. The produce of each partnership amongst the workmen is always kept separate in going through the various operations. The ore is next carted to the smelting works, which consist of roasting furnaces, reverberating furnaces, ore hearths, and slag hearths, and is ultimately run into bars or "pigs" of lead. Gun shot was at one time manufactured extensively at Leadhills, but has not been made for many years. A sample of it now shown from the "Braidwood Collection" was preserved by the care of the late Dr. Milligan of Wanlockhead.

The process of desilverization is carried on at Wanlockhead, and is not only a very beautiful but a most interesting one, this being the only place where it is worked in Scotland. After the silver is separated from most of the lead by being passed through a series of melting pots, it is taken to the refining furnace, in the bottom of which there is a cupel of bone and pearl ashes for the purpose of resisting the intense heat used in the process. Being melted, it is poured into the furnace, when a cross blast of air with flame is passed over the surface for the purpose of oxidizing the lead, which is thus carried off, leaving the pure silver behind. The oxidized lead, or litharge of commerce, which, when it first solidifies, is not unlike burnished gold, is produced in considerable quantity, and is an important article in colour-making and for various chemical purposes. As the plate of silver "sets" it presents most curious and fantastic forms and colours.

A curious arrangement is also at work for precipitating the lead which formerly passed away from the works in vapour with the smoke, and which was productive of great injury both to

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animal and vegetable life. The smoke is first exposed to the action of water in the shape of fine spray, and then to a great superficial area of cooling surfaces in large passages which wind round the hillside. About 58 tons of lead were deposited in about seven months, and the total cost of erection is expected to be repaid in less than two years. No silver is recovered along with the lead in this operation.

I shall now describe the principal lead-bearing veins at Wanlockhead. Belton Grain vein was worked at a depth of 130 fathoms and was considered very productive, but has been abandoned for many years. Cove vein, 300 fathoms west of the former, was wrought 66 fathoms deep below the level,* and was also productive, but is now abandoned. Both are used as reservoirs for supplying the pumping machinery with water required in the veins now being worked. Lochnell or South End of Cove vein was wrought 80 fathoms below level, and proved exceedingly good, but is now abandoned. Engine pit is all in good lead-bearing strata, the vein averaging 4 feet in width. At a depth of 56 fathoms a drift is driven 170 fathoms to another engine pit named the Corner o' the Hill. All this distance lead is found in greater or less quantities. A drift 20 fathoms higher up runs right through the Dod Hill. Old Glencrieff was another fine vein, but after being wrought for a long series of years it has been abandoned. New Glencrieff.—The level for this mine is driven for upwards of a mile, the depth of the northern part of the workings being about 140 fathoms, the water here being pumped out by a large water-wheel. This mine is very productive, although there are occasionally met with "checks" or barren parts of the vein of from 60 to 70 fathoms. The southern part now wrought is about 300 fathoms south of the northern workings, a shaft being down from the level 60 fathoms, and the water is pumped by a hydraulic pressure engine. Knots of lead ore rich in quality are found here.

These veins all run nearly north and south—not in straight lines but winding—consequently the drifts vary in going south from 5 to 15 degrees E. to S. of 15 degrees W. of S., but in all

* What is meant by "level" is this: The lowest end of the village is where the "level" issues its water to the surface, and the miners reckon always from this spot. In several of the workings there must be many fathoms from the "level" to the surface.

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the workings the medium point is found to be S. and N. The tops of the veins lie to the W., and they slope to the E. at an angle of from 68 to 45 degrees from the horizon.

The lead does not always lie in one position in the vein, but sometimes on the "ledger" side, sometimes on the "hanging" side, frequently in the centre, and at other times through its entire width. The "stuffs" or minerals which accompany it are very variable. In some places there is nothing but lead ore, which is in other places surrounded by what the miners term "vein stones," while at another spot there are fine crystals of varying composition. Amongst the layers which line the sides of the veins are (1) manganese, (2) brown iron ochre, (3) calamine, (4) galena, (5) brownish ferruginous quartz, so friable that it can be disintegrated by the hand. Here are often found fragments of copper. The middle of the vein is often filled with manganese, in which fragments of Silurian rocks abound. Occasionally the manganese contains crystals of quartz and masses of galena. There are frequent small cavities lined with calamine and lead in various combinations.

The appearance of the strata of the district generally shows that they have been much affected by earth movements, and that the resulting rents and fissures have been utilized in Nature's laboratory as convenient spots for the formation and retention of metallic wealth.

The study, therefore, of such districts as those of Leadhills and Wanlockhead is highly worthy the attention of all geologists, for only by such means can we hope to arrive at a true conception of the history of our globe, and experience a pleasure at the same time that is inexhaustible.

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## OLD MS. RELATING TO GOLD MINING.

THIS curious but imperfect MS., in the Cottonian Library, gives a most faithful description of the gold region of Crawford Moor, with the quaint views held at the date it was written on mining operations and theories. It has evidently been drawn up with great care and minuteness, which causes all the more regret that it is so fragmentary. The author's name and the date are awanting. It is marked Otho Ex. 12. It runs as follows, the words in italics having been added as an attempt to complete the sense, as far as possible :—

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"First. I have been informed, in King James *IV.'s time* Scottishmen did begin to washe gold, and in King *James V.'s time*, *in some* summers there was three hundred persons which did maintain *themselves by getting* gold, but for this forty last years there hath been little *washing*, *but in the* foresaid eighty years many gills, waters, and valleys have *yielded gold* therein of greater value than an hundred thousand pounds, *yet by the* people working for gold no veins of gold have been known to be found.

"Secondly. Gold hath been gotten by washing by the L. of Markesdale, distant from Leadhills House in Crawford Moor 28 miles, and hath been gotten in Langham Water 14 miles, and Meggat Water . . . *and* Phinland 16 miles distant from Leadhills House, and in many other *places*, by testimony of sundry reputed honest, which gold to have been gotten in *places* so far distant one from another doth shew there are either many *or that* the gold so found is generally dispersed, and doth but lie in the *surface* and not in solid and knit veins.

"Thirdly. There hath been adits or drifts driven in the works for conveying *water from the* lead mines, about 120 fathoms in Glengonnar Water, as also other drifts, *as* in Glanggres Gill, near Wanlockhead, for conveying water from a . . . gold having been plentifully gotten, and at a lower level within several former drifts, yet not any veins of gold have been known to be found *in levels or* drifts.

"Fourthly. The gills, many of them being in ascent from the level of the 4 . . . in the valley above 120 *feet* [*or fathoms*] and the little springs running down the said *gills* disturbed sundry leaders and some veins of copper and lead, yet in that *way the* workmen have not found any known veins of gold.

"Fifthly. Although gold have been found in more than 40 several gills falling *into the* greater Waters of Alroyn, Glengoner, Wanlock, and Mannock, and along the sides and in the channels of the said great Waters, yet the same gold may *be seen* dispersed in certain black rocks of chiver next the heads of the gills, *such as* I have found in Clanclough and Tempie Clough, having seen many times Iron *Pyrites*, Marcasites, and Lead ore to be growing in like black chiver rocks, but have never *found* the said rocks to contain anything solid or . . . containing veins of any of the former metals, conceiving the said rocks as unnatural vessels for veins of metal." This concludes one folio of the MS., which seems to have been headed, "These reasons make *me think there are no veins of gold*, . . . but rather lying dispersed *on the surface* of the *ground*."

The heading of the next folio is very imperfect and seems to have suffered still more than the first from fire. It refers to veins of gold in sundry parts of Crawford Moor, but the beginning is so mutilated that it cannot be satisfactorily made out. It, however, describes the views of the gold washers and lead miners as to certain veins or indications, which they called leaders, lingetts and liggets, or husband and wife, leading to the mother ore. These leaders the writer considered to be tinged by the metalline fumes of the main lodes, and to be infallible guides to them, if followed up; and he draws a comparison with a chimney of a house "as through a chimney the smoke will show the nature of the fire below, so the

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sides of the rocks along which the same doth pass, which tinctures, colours, or metalline fumes an expert miner will thereby discern whether the vein at a depth be apt for iron, lead, *tin*, copper, or silver, and I have observed in two several places in which I have found . . . together between two rocks spar, keile, and brimstone, all which are found wherever gold is gotten by washing, and therefore called by the gold washers the . . . of gold. The like of which foresaid leaders I have not seen in colour and *quality* either in Cornewall, Devonshire, Somersetshire, . . . wheresoever I have travelled, but only in those places where *gold* is found in Scotland, which, together with the bluish and yellow coloured *mothers*, I am persuaded are leaders to veins of gold either at a depth, or in this . . . , and may be best tried by damming, driving, and shafts sinking *so far and so* deep, as the directors shall think fit.

"Secondly. By a report of sundry workmen some whereof affirm that at Pont Shields and Wanlock Water, and in sundry other places, they have found gold in bigness of cherrystones, and some greater pieces lying between two rocks in a yellow or blewish mother or leader, which they have followed about five foot deeper than the water, would pass from their work, but by casting, at which time they did not know the use of shafts and buckets, and therefore were enforced by influence of waters and thickness of the earth to desist from working of such gold works, which places may be tried in some few months, and if answerable to their report the veins of gold will be soon discovered.

"Thirdly. By testimony and voluntary oath of such as have found pieces of gold, and have seen some found by others, one piece of thirty ounces, and some of greater weight, which were flat and mixed with brimstone, and the Lord of Markestone (Merchiston) did shew me a piece of three quarters of an ounce and some lesser . . . , those pieces were torn by the force of water, . . . of the waters since that time, whereby I do *conclude that spar, keile, and* brimstone are leaders to the veins of gold.

"Fourthly. Wheresoever gold is found by washing there *are* . . . . . found therewith which are not flat beds lying about the . . , . . smoother, as though torn from the veins and tossed by *the water and* made smooth, like to those stones which being carried by *violence of* brooks and rivers do grow smooth and are not so rough as the same quarries which grow or remain in their beds.

"Fifthly. The gold washers' ignorance hath been such as they did *not seek where* were any veins of lead or copper, neither of keile, brimstone, or spar, which have been known to them within the last ten years, that though descending into the depth between two rocks, which they constantly *have* seen gold growing in the former metals in sundry places, and . . . . . conceiving that there be sundry veins of the same metals, they . . . . . to find the veins of gold growing therein.

"Sixthly. I find the great works for gold to have been along the *sides of the* great Waters, in the valleys between the mountains and along the *waters and* gills, and as the inhabitants report having made many trials in the sides of the hills and gills, though but 200 yards from the former *workings in* the waters, in the valleys and gills they found not gold, and by . . . . .

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said leaders or metalline fumes give divers tinctures and colours to both his works he affirmeth the like, and I having made two days' trials *on the* tops and sides of the hills did likewise not find gold, so as if not *thoroughly* dispersed, but lying in some places as the said workmen affirmed in *a manner of* being drawn together into lesser room, and straiter the same are . . . . . shews that there are veins of gold, and the rather that there hath been plenty of gold gotten in the cloughs and gills 80 fathoms above the foresaid waters in the valleys, which gold being ponderous and *bulky*, must by common reason descend, was consequently, whereas some pieces of *gold* of above 30 ounces weight have been found in the said gills, the same must *either* grow thereabouts, or by violent waters be driven out of higher places, where they did grow within the circumference of those places where the gold is found."

## MINERALS.

From the various mines of Leadhills and Wanlockhead I have obtained specimens of the following minerals, mostly in very fine condition. Where localities are not given they have been found at both places.

| | |
|---|---|
| Quartz, various forms of crystals. | |
| Amphibole, Rock Cork, | Leadhills. |
| Calcite, Plumbo-calcite. | |
| Dolomite, Bitter Spar, | Wanlockhead. |
| Arragonite. | |
| Fluorite, | Wanlockhead. |
| Barytes, Heavy Spar. | |
| Witherite. | |
| Alstonite. | |
| Baryto-calcite. | |
| Strontianite. | |
| Siderite. | |
| Calamine, Smithsonite. | |
| Willemite, Troosite, | Wanlockhead. |
| Chessylite, Azurite. | |
| Chrysocolla, | Wanlockhead. |
| Malachite. | Leadhills. |
| Olivenite. | |
| Annabergite, Nickel Ochre, | Wanlockhead. |
| Cerussite, Lead Carbonate. | |
| Anglesite. | |
| Leadhillite. | |
| Susannite, | Susannah Mine, Leadhills. |
| Lanarkite. | |
| Caledonite. | |
| Pyromorphite. | |
| Mimetesite. | |
| Linarite, | Leadhills. |

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| | |
|---|---|
| Vanadinite, | Wanlockhead. |
| Dechenite, | Leadhills. |
| Hæmatite. | |
| Uraninite, Pechuran, | Wanlockhead. |
| Plattnerite, | Leadhills. |
| Psilomelane. | |
| Minium. | |
| Cuprite, | Wanlockhead. |
| Melaconite, | ,, |
| Gold. | |
| Nickeline, Copper Nickel. | |
| Copper Pyrites, Chalcopyrite. | |
| Marcasite. | |
| Pyrrhotite, | Wanlockhead. |
| Galena. | |
| Stibnite, Antimonite. | |
| Blende, Sphalerite. | |
| Chalcanthite, | Wanlockhead. |
| Wad, Bog Manganese, | Leadhills. |

## No. XLI.—On a Specimen of *Psephodus Magnus*, Agassiz, from the Carboniferous Limestone of East Kilbride, Lanarkshire.* By R. H. Traquair, M.D., F.R.S. With a Plate [No. XVI.]

[Read 17th May, 1883.]

In his "Tableau générale des Poissons Fossiles," published in 1844, and appended to the first volume of his great work, Agassiz enumerates five species of his Carboniferous selachian genus *Cochliodus*, of which he only described one, the well-known *C. contortus;* the others, of which names only were then published, being *C. magnus*, *C. acutus*, *C. oblongus*, and *C. striatus*.

*C. magnus* was, however, figured by Lieut.-Col. Portlock in his "Geological Report of Londonderry and parts of Tyrone and Fermanagh" (Pl. 14a., fig. 4). It is a large, broadly oblong convex crushing tooth, with crenulated edges, common at Armagh,

*This paper has subsequently to the date of reading been re-written by the author in consequence of the publication by Mr. J. W. Davis and by Messrs. St. John and Worthen of important matter bearing on the subject.

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in Ireland, and not at all rare in the Carboniferous limestone of many localities in Scotland. In the same work (p. 462) Col. Portlock quotes a letter from Captain Jones, in which that gentleman, a zealous collector of fossils from the Armagh limestone, expresses the opinion that this tooth passes into *Helodus planus*, another Armagh species, named but not described by Agassiz.

Both *Cochliodus magnus* and *Helodus planus* were described, and the latter also figured, by M'Coy, who still retained them as belonging to separate genera and species, for though he mentions Captain Jones's opinion regarding them, he states that he himself had not seen the passage. As regards *C. magnus*, M'Coy assigned three teeth to each ramus of the jaw, so as to form an arrangement corresponding with that in *C. contortus*. He also doubted the position of the species in the genus *Cochliodus* on account of the slight enrolment, the little definition of the characteristic oblique ridges, and the strong crenulation of the edges.*

Agassiz having visited Great Britain again in 1859 extensively revised the names of the Carboniferous selachian remains in the magnificent collection of the Earl of Enniskillen, at Florence Court, in Ireland, and instituted a great number of new generic and specific names, involving in many cases considerable subdivision of former genera. A list of these MS. names was supplied by Lord Enniskillen to Messrs. Morris and Roberts, and published by them in the *Quarterly Journal* of the Geological Society, 1862, pp. 99-102. From this list it appears that out of the previously quoted species of *Cochliodus*, except the first, *C. contortus*, a number of new genera, as well as several additional species, were established. *Cochliodus magnus* from Armagh became *Psephodus magnus*, with which *Helodus planus* was merged; *C. magnus* from Bristol became *Tomodus convexus*; *C. acutus* became *Deltoptychius acutus* and *gibberulus*; *C. oblongus* became *Streblodus oblongus*, *Colei* and *Egertoni*; and lastly, for *C. striatus* the genus *Xystrodus* was proposed with the additional species.

Teeth undoubtedly generically identical with Agassiz's *Psephodus* were in 1866 figured by Messrs. Newberry and Worthen, under the name of *Aspidodus crenulatus*.† The authors refer to the resemblance which these teeth bear to Agassiz's *Cochliodus magnus*, and suggest that the latter, as well as *Helodus planus*,

* "British Palæozoic Fossils." London and Cambridge, 1855.

† Geological Survey, Illinois, vol. ii., p. 92.



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should be included in *Aspidodus*. In this Messrs. Newberry and Worthen would have been perfectly right had *Psephodus* been a *mere* MS. name like so many others which Agassiz left behind him at Florence Court. For though no definition of *Psephodus* appeared along with the publication of the name in 1862, its type species, *magnus*, had been sufficiently well figured and described by Portlock and M'Coy to enable naturalists throughout the world to identify the genus. We may, therefore, grant priority to Agassiz's name, though solely on the grounds above given. And in the sixth volume of the Geological Survey of Illinois the name *Aspidodus*, given by Messrs. St. John and Worthen, is relinquished in favour of *Psephodus*.

It is indeed much to be regretted that Agassiz did not himself publish figures and descriptions of the numerous genera and species of fossil fishes to which in various collections he affixed MS. names, and in hardly any department did the non-completion of his work hinder progress more than in the case of those selachian remains from the Carboniferous limestone contained in the Florence Court collection. Many of those names given by him in his revision of 1859 became current among collectors without their having any published means of verifying their identifications, and the names themselves being MS. names still, in spite of their publication by Messrs. Morris and Roberts, were liable at any moment to be superseded. This want, has, however, been supplied by Mr. J. W. Davis, who, having been entrusted by Lord Enniskillen with the task of working up the Carboniferous limestone selachian remains in his collection, last year published descriptions and figures of the genera and species there named by Agassiz, along with many others established by himself as new. And the Enniskillen collection itself having been recently acquired by the British Museum, the scientific public at large have now ample opportunity of knowing the present condition of this branch of palæichthyological science, so far at least as specimens from British Carboniferous rocks are concerned.

In this work* Mr. Davis follows M'Coy in assigning three principal teeth to each ramus of the jaw of *Psephodus magnus*, and has given a figure representing three such teeth placed together in the position he supposed them to occupy. Admitting *Helodus*

* "On the Fossil Fishes of the Carboniferous Limestone Series." Sc. *Trans. Roy. Dub. Soc.* Vol. i. ser. 2. 1883. (Read May 15, 1882.)

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*planus* as a synonym, he assigns to these "Helodoid" teeth a position—some in front of the larger plates, others on the palate between them.

Mr. Davis summarizes his views as follows:—"That a row of three principal teeth, increasing in size backwards, were attached to each cartilaginous ramus of the jaw; that the diameter of the jaw, as indicated by the groove or channel on the under surface of the teeth, diminished towards the symphysis; that a long narrow tooth was placed in front of the anterior one, and that a series of at least three Helodoid teeth were placed behind it, extending over the palate and increasing in size backwards." The following sentences may also be quoted:—"It is not probable that more than three teeth existed on each side of the jaw; and the teeth hitherto known as *Helodus planus*, Ag., occupied the intervening portion of the palate. An example (Pl. LV., fig. 6) shows a Helodoid tooth to have occupied a position in front of the anterior tooth, as well as the palatal space behind."

These views appear, however, to be in the main hypothetical. The "three principal teeth" have not, so far as I am aware, been found together in the positions ascribed to them; nor does it seem clear what Mr. Davis means by the "intervening portion of the palate," or the "palatal space," unless he supposes these Helodoid teeth to have been unsupported by the cartilaginous jaw arches, mandibular below and palato-quadrate above, which is certainly improbable. One of his figures (Pl. LV. fig. 4), however, shows three of the Helodoid teeth in longitudinal apposition; another (fig. 9) two similarly related to each other, and to a broad tooth; and again (fig. 6) we have one of the narrow teeth lying alongside the trigonal one, supposed by M'Coy and himself to be "anterior."

Mr. Davis's paper was read before the Royal Dublin Society, May 15, 1882, and published during the following year. But also in the same year (1883) appeared the seventh volume of the Geological Survey of Illinois, containing extensive new researches among the Carboniferous selachian remains of that region by Messrs. St. John and Worthen, and made independently of Mr. Davis's work. In this volume a considerable share of attention is given to the germs *Psephodus*, and the results certainly do not correspond with the views of Mr. Davis. While the authors state that "in reference to the dentition of *Psephodus* our infor-

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mation is still meagre," they seem to have come to the conclusion that "while the median portion of the rami of the jaws of *Psephodus* was enveloped by a moderately-contorted dental plate, this plate was flanked on either side by series of teeth disposed in rows from within outwards, similar to the occurrence of the teeth upon the jaws of *Cestracion*." And as regards the allocation of the larger dental plates, one form apparently corresponding with the supposed "posterior" tooth of M'Coy and Davis is provisionally referred to the lower jaw, while another resembling the supposed "middle" tooth is in like manner referred to the upper jaw.* Moreover, on the 8th December, 1881, prior to the reading of Mr. Davis's paper, Mr. James Coutts exhibited before the Geological Society of Glasgow a remarkable specimen of *Psephodus magnus*, discovered by Mr. A. Patton in the shale accompanying the cement-limestone of East Kilbride, and his remarks upon it were published also in 1883. In this specimen we have remains of the cartilage of the jaws, along with an aggregation of teeth, which undoubtedly belonged to the same mouth. Concerning the teeth here exhibited, Mr. Coutts remarks:—"The two largest teeth evidently belong to *Cochliodus magnus*, or, as it is now given in the 'Catalogue of Western Scottish Fossils,' *Tomodus convexus*, Agassiz. Others of the teeth agree closely in form with *Helodus planus*, now *Psephodus magnus*, Agassiz, thus confirming Captain Jones's opinion that the teeth of *Cochliodus magnus* and *Helodus planus* belong, in all probability, to the same fish. Some of the teeth in this specimen agree very closely with *Helodus mamillaris*, Agassiz, while others differ in form from any of the species indicated; indeed, it is very doubtful if there are any two teeth exactly alike, but this is a feature common to the group of fishes to which the specimen belongs." From the dates it will be seen that the remarks of Mr. Davis and Mr. Coutts, in this form, were written and published altogether independently of each other.

Through the kindness of Messrs. Patton and Coutts, this very interesting specimen has been entrusted to me for re-examination, and in the present communication I propose to give a more detailed description of the facts and features which it displays.

The specimen is contained on a nearly rectangular slab of shale 9½ inches in length by 4 in breadth. That which we may call the

* p. 64.

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*anterior* half of the surface (Pl. XVI., fig. 1) is occupied by remains of cephalic cartilage, with teeth, behind which, on the posterior half, we find some obscure remains of a vertebral column. The most prominent object which strikes the eye on the anterior part of the slab, and lying close to what may, for convenience, be called the lower margin, is a piece of calcified cartilage, $3\frac{1}{2}$ inches in length, of an elongated form, gently curved, and broader behind than in front, which one feels much tempted to regard as the ramus of a jaw. Close to and slightly above the hinder extremity of this cartilage is one of the large dental plates of *Psephodus magnus* (*a*), lying with its deep or concave surface upwards; but it may be lifted from the matrix and freely examined on all sides. This dental plate (seen isolated and from the convex surface in fig. 3) is one of these trapezoidal teeth, considered as "middle" by M'Coy. All its margins are crenulated, save the so-called inner margin, with which very distinct lines of growth run parallel.

In front of this tooth, and extending to the anterior margin of the slab, are seen many irregularly placed small Helodoid teeth, above which again the surface is mainly covered by calcified cartilage, through which (at *b*) the broken margin of another large tooth may be seen projecting. A fracture enables us to raise this cartilaginous portion of the specimen, bringing into view upon its under surface (fig. 2) a large number of additional teeth, among which is the large one whose broken edge I have already alluded to. This is firmly fixed to a stout long-shaped piece of cartilage, resembling a jaw ramus, which is not, however, preserved in its entirety, being obliquely broken off in front. The tooth itself (fig. 4) belongs to the category reckoned by M'Coy and Davis as the "posterior" tooth of *Psephodus magnus*, and of this it represents one of the rude convex varieties. The margin regarded by M'Coy as "inner" is broken away; the anterior and posterior margins are crenulated; the so-called "outer" bent margin is entire and smooth.

These two teeth, above described, are the only large ones seen in the specimen. They undoubtedly belong to *Psephodus magnus*, Agassiz, and not to *Tomodus convexus*, as stated by Mr. Coutts; but his mistake is readily excusable when we consider the difficulty and, in many cases, impossibility, of identifying Agassiz's MS. genera, until the appearance of Mr. Davis's work.

There are no less than forty-four smaller teeth exhibited in the

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specimen. Mr. Coutts mentions thirty-two, including the two large ones; but by careful working out I have been able to uncover the additional number. They are mostly rather confused in position; but, as seen in fig. 2, several groups occur of two, three, and four in apposition. The most posterior of these smaller teeth (*c*) is isolated from the rest, and somewhat resembles *Helodus rudis* of M'Coy, though smaller in size. It is oval in shape, $\frac{1}{4}$-inch in length by $\frac{1}{8}$ in breadth, slightly convex on the surface, and with its margin sloping and complicated.

More than twelve of the teeth (*d*) in front of this and lying between the two larger ones are clearly identifiable with *Helodus planus*, though they exhibit considerable variety in size as well as shape; the largest being nearly one inch, the smallest $\frac{3}{8}$-inch in length. Some of them are much broader behind than in front, with oblique posterior margins, others are more rectangular; some exhibit considerable lateral convexity of the crown, on others the surface is more flattened; in all, the margins are crenulated.

Closely behind the large tooth (*b*) may be observed four teeth of a peculiar form (*e*), three of them being in apposition. The largest of these is $\frac{5}{12}$ inch in length by $\frac{1}{6}$ in breadth; the shape somewhat rectangular, but from the middle of one margin a small angular point projects over the tooth next in advance. The margins are crenulated.

The remaining teeth are placed in advance of those already described, and most of them, where their shape is clearly exhibited, present the characters of Romanowski's genus *Lophodus*,—a genus instituted for those Helodont teeth which possess a well-marked, more or less compressed, and vertically striated or crenulated root. Among these considerable variety of form may be observed. One at least (*f*) is referable to *L. didymus*, Ag. sp., showing a broad prominent central elevation or boss, which "posteriorly" is distinctly divided into two smaller ones, below which and close to the margin of the crown is a small angular prominence. Though the division of the central elevation of the crown is feebly indicated in at least one of the others, in the rest it disappears, and the teeth assume the characters of *L. lævissimus*, Ag., sp. (*g*); finally, all definition of the boss ceases, the crown ultimately becoming nearly flat. In some of these "*lævissimus*" forms the boss is markedly unsymmetrical, being much more sharply defined on one side than on the other.

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Concerning the rest of the specimen not much is to be said. Immediately behind the large tooth (*a*) there is a flat piece of osseous matter $\frac{1}{1\frac{1}{2}}$ inch in length by $\frac{5}{8}$ in breadth, concerning which I am unable to offer any opinion. The remains of the vertebral column, of which a length of three inches is preserved, are limited to a set of elongated closely-placed spinous processes, which are, however, very obscurely seen; there is no trace of vertebral bodies, so that, as might be expected in a Palæozoic Selachian, the notochord must have been persistent. One or two minute, sharply-ridged, shagreen bodies may also be observed.

*Observations.*—Although the above-described specimen is one of great importance for Carboniferous Selachology, our first reflection must be that we are far from having the entire dentition of the fish before us, and that a considerable portion of the specimen must have been lost. It is very improbable that the species possessed less than four of the large tooth plates—one on each side above and below—but were only one pair present the two would be symmetrical with each other. Here we have two of these plates present, belonging respectively to the forms supposed by M'Coy and Davis to be the first and second tooth of a cochliodont dentition, but the mode in which they occur lends no support whatever to that theory. Much more probable does it seem to me that the view of Messrs. St. John and Worthen is correct, namely, that these two forms of teeth belong to different jaws, upper and lower. Which belongs to which we have, however, no really accurate means as yet of determining. Messrs. St. John and Worthen refer the broader teeth (*b* of the present specimen) to the lower jaw on account of "the somewhat stronger resemblance" which they have in form "with the contour of the mandibular teeth of typical cochliodonts."

But whether the form (*a*) or the form (*b*) be upper or lower, I must hold that these larger tooth-plates in *Psephodus* present an unmistakeable analogy in form with those of *Cochliodus*. And if this be the case, the long side of each along which the progressive increase of the tooth took place as indicated by the lines of growth, must be *internal* in position, and not *external* as it is placed by Mr. Davis in his figures. This position also brings the oblique directions of the undoubted anterior and posterior margins into harmony with those of the anterior and posterior margins of the great posterior tooth of *Cochliodus*, and of the lines separating the

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rows of teeth in the recent *Cestracion*, which all cross the jaw obliquely from within outwards and forwards—a direction precisely opposite to what is seen in Mr. Davis's hypothetical figure of the dentition of *Psephodus*. Mr. Davis seems to be quite aware that in placing the teeth so he has departed from the analogy of *Cochliodus*, for, while he admits that in that genus and in Cochliodontidæ generally, the inrolled teeth increase from the inner side, he states that in *Psephodus* the increase takes place along the opposite or outer side (*op. cit.* p. 416). It does not seem clear on what reasons this opinion is founded.*

The imaginary nature of Mr. Davis's restoration is further illustrated by the fact that in the present specimen the two teeth of the forms supposed by Mr. Davis to be "posterior" and "middle" are nearly exactly of the same length. This is indeed what we might expect if they belonged to upper and lower jaws, whereas in the figure referred to, the supposed "middle" tooth is, to suit the tapering form of the jaw, much smaller than the "posterior" one behind it.

On the whole, I consider that view to be most likely to be correct, which would ascribe to the mouth of *Psephodus* four large tooth-plates—two above and two below—each occupying on the ramus a position similar to that of the row of largest teeth in *Cestracion*, or of the so-called median tooth of *Cochliodus*, but that of the upper jaw differing slightly in form from the one opposed to it below. If Messrs. St. John and Worthen's allocation of these larger teeth be correct, the tooth (*a*) of the present specimen will belong to the right half of the upper jaw, while (*b*) will be that of the left half or ramus of the mandible.

The subtrigonal tooth considered by M'Coy and Davis as "anterior" does not occur in our specimen, but it clearly appertains also to *Psephodus*, and there is no reason why it should not also have occupied a position in front of the large ones (*a*) or (*b*).

Teeth of different forms seem to have been present in the jaw external to and in front of the large plate, those in its immediate vicinity belonging more or less to the category of *Helodus planus*,

* In placing the long or obtusely angulated margin of the supposed "posterior" tooth (*b* of our specimen) outwards, Mr. Davis apparently follows M'Coy's description. But in describing the supposed "middle" tooth (*a*) M'Coy calls its long margin "inner," and though Mr. Davis quotes this description verbatim, he, nevertheless, with some inconsistency places the long margin in exactly the reverse position, namely, *external*.

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including the peculiar forms figured (*e*), and that resembling *Helodus rudis*. But the front of the jaw was armed with small teeth belonging to the type, which has been designated as *Lophodus* by Romanowsky, and the forms *didymus* and *lævissimus*, both named as species of *Helodus* by Agassiz. Hence, not only must those species be merged in *Psephodus*, but the genus *Lophodus*, founded upon *H. didymus* and allied forms, ceases to have any but a conventional existence. It would, I think, have been well, before separating off any new genera from the old *Helodus* of Agassiz, to have sought for more precise information as to the essential characters of the coal-measure species *H. simplex*, which, as it occurs first both in Agassiz's systematic catalogue and in his descriptions, must, according to the rules usually followed, be considered as the type of the genus. It is to be hoped that more satisfactory information as to the real characters and affinities of that form may soon be forthcoming. Meanwhile it would seem that the teeth known as *Lophodus* are in fact those situated in the anterior part of the mouth of genera more or less allied to *Cochliodus*. For although Professor Owen, in his paper "On the Teeth of Cochliodonts," held that there was "no ground for assuming that the symphysis were prolonged, as in *Cestracion*, for the support of conical or any other teeth," * Messrs. Newberry and Worthen have, as is well known, described a species of *Cochliodus* (*C. nobilis*) from the Carboniferous limestone of Illinois, in which, with the Cochliodont plates, were associated teeth of decidedly Lophodont configuration (*Helodus nobilis*, N. & W.) in such a way as to lead to the belief that these "occupied the central portion of the jaw in two or more rows between the large convoluted teeth which we have described under the name of *Cochliodus nobilis*." And regarding the very species of *Lophodus* occurring on our present specimen, these authors remark on a previous page:—"The median teeth of *Cochliodus*, a group which must include several described species of *Helodus* (e.g., *H. lævissimus*, *H. didymus*, *H. turgidus*, &c.) have been found in regularly diminishing series like some of those now figured." † It is now shown that two of those (viz., *lævissimus* and *didymus*) occupied a position in the front of the mouth of *Psephodus*, which, although not *Cochliodus*, has certain obvious points of affinity with it. *Psephodus* is still included in the Cochliodontidæ by Messrs. St. John and Worthen. ‡

* Geol. Mag., vol. iv., 1866. † Geol. Survey of Illinois, vol. ii., Palæontology.
‡ Geol. Survey of Illinois, vol. vii., Palæontology.

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## EXPLANATION OF PLATE XVI.

Fig. 1. Anterior part of the specimen of *Psephodus magnus* described in the text, showing what remains of the teeth and cartilage of the jaws.

(*a*) Tooth supposed to be the "middle" tooth of *Psephodus magnus* by M'Coy and Davis, seen from its attached surface.

(*b*) Portion of tooth supposed by these authors to be the "posterior" tooth.

(*g*) Teeth referable to *Helodus* or *Lophodus lævissimus*.

Fig. 2. Portion of the same specimen split off and turned up showing additional teeth.

(*b*) Tooth whose broken margin is shown at *b* in the previous figure.

(*c*) Tooth of type of *Helodus rudis*, M'Coy.

(*d*) *Helodus planus*.

(*e*) *Helodont* teeth of peculiar form.

(*f*) *Helodus* or *Lophodus didymus*.

(*g*) *Helodus* or *Lophodus lævissimus*.

Fig. 3. Tooth *a* in fig. 1, seen from its convex surface.

Fig. 4. Tooth *b* in figs. 1 and 2, seen from its convex surface.

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## No. XLII.—Some Notes on a Fossiliferous Shale, a little below the Cloch Lighthouse. By Thomas Scott, *Cor. Mem.* With a Section. [Plate XVII.]

[Read 8th May, 1884.]

One day in October of last year while walking round by the Cloch, I happened to take a look at the rock sections seen near the shore in that neighbourhood. Being aware that the sandstone rocks exposed for a considerable distance along our coast line—that is south-westwards, from Greenock and Gourock—belong to the calciferous sandstone series, and being also aware that organic remains have been found in this series of rocks in different parts of Scotland, the thought often occurred to me that vegetable or animal remains might be found in the similar strata here. I was thus often tempted, while botanizing by the shore, to take a look at the rocks in passing, and on the day mentioned I examined some alternating beds of sandstone and shale exposed near the shore, about a quarter of a mile below the lighthouse.

Some of the sandstones contained carbonaceous matter, which was quite structureless, but on carefully examining one of the beds of shale I found part of it crowded with vegetable remains, consisting for the most part of ferns and calamites—one species of

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Fig. 1.

From Nature by R. H. Traquair, M.D.

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# PSEPHODUS MAGNUS, *Agassiz.*

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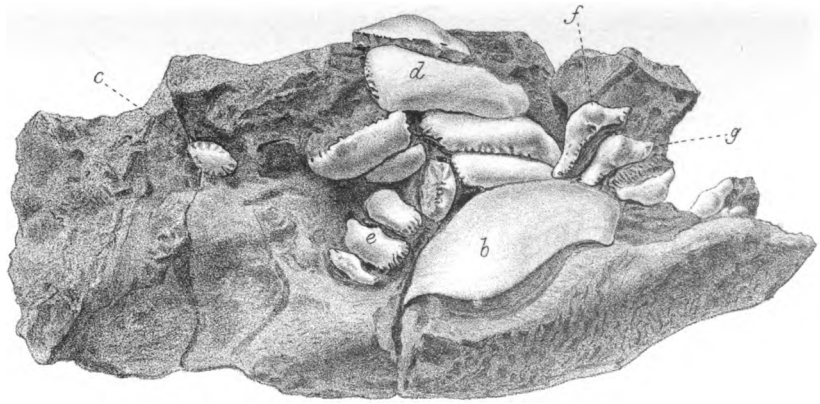


Fig. 2.

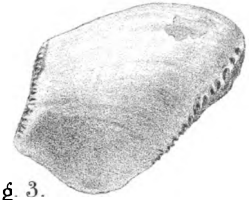

Fig. 3.

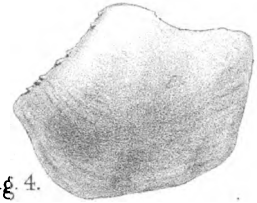

Fig. 4.

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Thos Scott fecit. 1824.

Fig. 1.

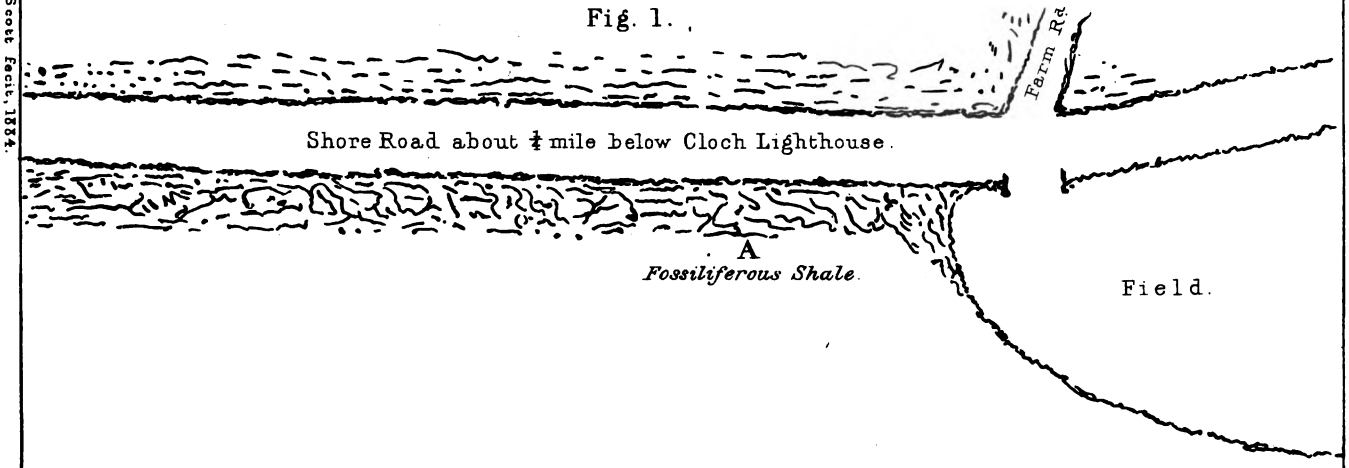


Fig. 2.

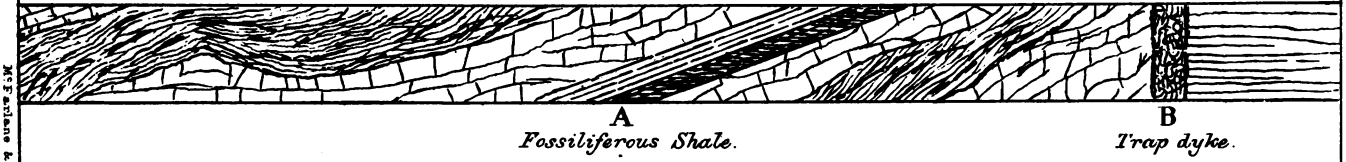


DIAGRAM indicating position of FOSSILIFEROUS SHALE near Cloch Lighthouse.

M.cF arlane & Erskine, Lith.rs Edin.r

fern, the *Sphenopteris affinis*, being in great abundance in some parts, and *Calamites cannæformis* equally plentiful in other parts; while very sparingly appeared the fern, *Pecopteris dentata*. On the top of the fossiliferous part of the shale I found a piece of tree stem, but not sufficiently preserved to allow of it being identified. I wish here to say that I am much indebted to Mr. John Young, F.G.S., to whom I submitted specimens, for his kindness in examining and identifying the species named. As the changes that have taken place in the structure of the tree stem are rather interesting, I shall take the liberty of quoting what Mr. Young says:—"No. 1 is a portion of a squeezed stem of what I think has been some coniferous plant. It has been very much bituminized so as to have lost all trace of its original woody structure, and has been subsequently altered by heat, so that it now gives very little flame. I noticed it contains some minute crystals of iron pyrites, and some fissures are filled with green carbonate of copper (malachite), which is elsewhere found in the Gourock beds."

Now, before proceeding further, I will try to point out as near as possible where the fossil-bearing shale occurs, and the section herewith [Plate XVII.] will help me in doing so. The road for some distance past the Cloch Lighthouse closely skirts the shore, but proceeding we come to a place where the road bends a little inland, while the shore bends for a short distance rapidly outwards, so that a gradually widening field is situated between the shore and the road, as indicated by the section. Where the shore and the road thus part company we find the shale above referred to. The bed is fully three feet thick, with sandstone above and below, and dips to the north-east with an inclination of about 20 degrees, only half (the lower half) being fossiliferous. It is very friable, so that it is almost impossible to lift a large piece of it, and even when we do get a moderate-sized bit, we find that in drying it is very apt to break up into small fragments. I have already said that the structure of the piece of tree stem found in this shale has been very much altered; the alteration of the vegetable structure and also the friable condition of the shale itself having been probably caused by the action of the trap-dyke which is found about 30 or 40 yards to the south [Plate XVII., sec. 2]. The upper part of the shale is, so far as I can make out, entirely destitute of fossils. Wishing to know if the traces of

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copper, which were associated with the fossil tree, were derived from the enclosing shale, I got a friend to analyze a piece of it. He found "iron and alumina in great abundance, also silica—the iron appeared to be mostly in the ferrous state, mixed with a little ferric"—but there was no trace of copper, so that the copper we find associated with the fossil tree must be derived from some other source than the surrounding shale.

It would appear from the fossil contents of this shale, and from its thin laminated structure, that while it was being deposited the country round about, if not the whole of mid-Scotland, was a comparatively level marshy plain, through which possibly some slow-moving stream wended its course; that this plain was luxuriant with ferns, but which, although very abundant, did not present a great diversity of species. One species at anyrate predominated, and had a distribution over central Scotland from its east to its west coast line. That the river, or rivers, now and again overflowed and covered great tracts of the adjacent land and buried the luxuriant vegetation under a layer of mud. Ferns would again cover the land and be again buried, but after these alternations had gone on a while, there came a time when the soil seemed not so suitable for the growth of ferns, and calamites took their place, became equally abundant, and were equally subject to be now and again buried under the diluvium spread over the district by inundation. By and by trees flourished and helped to diversify the landscape. But another change ensued, the conditions became such that they could not support vegetable life, and consequently we find the upper part of the shale to be quite barren of organic remains. I have now touched on one or two points which the distribution of the fossil remains in this shale seem to indicate.

I wish now to say a few words on what appear to me to be some interesting features in connection with the relative position of the rocks, on each side of the trap-dyke [shown on the section, Fig. 2]. It will be observed that on the upper or north side the strata, consisting of alternating sandstone and shale, dip considerably, as I have already stated, to the N.E., while on the south side of the dyke the strata, consisting of conglomerates and fine-grained dark-red sandstones, are almost horizontal, having but a slight dip westwards, while there can be no doubt that the rocks on the north side of the dyke belong to the lower Carboniferous group. I am inclined to think that those on the south side are the lower

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red Calciferous sandstones, from their close resemblance to those about Wemyss Bay. If such be the case, we have here evidences of a very extensive displacement having taken place —the dark-red sandstones and conglomerates have undergone little change, but the calciferous sandstones and shales on the north side of the dyke have been extensively faulted down, in all likelihood during the time of volcanic activity, of which this trap dyke and others in the neighbourhood are the mementoes.

Time will not permit me to say more at present, but if what I have said leads to more interest being taken in the rocks along our coast line my purpose shall have been served. I may, however, explain that since I set myself to write these few notes a great many things have had to be attended to which curtailed my little leisure, with the result that I have been able to touch only on a few of the more salient points connected with the geology of this part of Clydesdale.

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# PROCEEDINGS FOR SESSION 1882-83.

## (25TH SESSION.)

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SOCIETY'S ROOMS, 207 BATH STREET, 12TH OCTOBER, 1882.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

The CHAIRMAN congratulated the members on the opening of another session, and remarked that he had every reason to believe the prospects of the Society to be encouraging. The number of working members was increasing, and on that, probably more than any other feature, depended a prosperous issue.

Mr. JAMES COUTTS exhibited specimens of calcareous Stalactites from the Sutors, at Cromarty, and sent by Mr. W. C. Dobbie, which showed well their structure, and the Chairman made some remarks upon the subject.

Mr. D. C. GLEN, F.G.S., who had represented the Society as delegate at the late meeting of the British Association for the Advancement of Science at Southampton, made a report on the business of the meeting. He also described an excursion taken by the members to the Isle of Wight, and exhibited a fine series of Sands and Fossils from Alum Bay there. Mr. Glen gave a graphic description of the sand-cliffs exposed in that famed locality, and said that the bright colours of the sand-strata were wonderful, and when once seen could never be forgotten.

Mr. JAMES COUTTS exhibited a fine specimen of *Gyrolepis Rankini*, from Mr. A. Patton's collection, and stated that the genus was founded by Prof. Agassiz on specimens obtained by the late Dr. Rankin of Carluke, in the Lower Coal measures of that district, the specific name being given in honour of the discoverer. The genus is characterized by its large rhomboidal scales, with boldly sculptured and curved striæ, and has only been found at Carluke, Crossbasket, and Highfield near Dalry. The specimen exhibited showed the bones of the head, the upper and lower jaws with teeth, also scales with upper and lower surfaces exposed and their curious peg-like mode of attachment.

Mr. JAMES WHITE read a paper entitled, "Thoughts suggested by a Visit to Skye, with some specimens of its rocks and fossils," in which he

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reviewed the impressions he had formed after a recent trip to the island, and an inspection of some of its more striking geological phenomena. Mr. White's paper was illustrated by a map of Skye and the adjacent mainland, and by a number of rock and fossil specimens.

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SOCIETY'S ROOMS, 207 BATH STREET.

ANNUAL GENERAL BUSINESS MEETING, 9TH NOVEMBER, 1882.

Mr. ARCHD. ROBERTSON, *Vice-President*, in the Chair.

The following gentlemen were elected ordinary members of the Society :—Mr. Hugh B. King, banker, Kilwinning ; Mr. Robert C. King, banker, Kilwinning ; Rev. John Macintosh, the Manse, Uddingston ; Mr. James S. M'Lellan, teacher, Oswald Public School, Maryhill ; and Mr. John Shaw, Southpark, Tollcross.

Mr. MURDOCH, Honorary Secretary, then read as follows :—

THE REPORT OF THE COUNCIL FOR THE PAST YEAR (1881-82).

The Council have again the pleasure of making their Annual Report upon the business of the previous session, the 24th of the Society's existence, and they have reason to think that upon the whole the progress attained has been satisfactory, and that the outlook for the future is favourable.

The membership has kept up to about the average of late years, neither increasing nor diminishing much, as will be seen by the Treasurer's Report, but the Council certainly expected, as was stated in their Report of last year, that the removal of the Society's meeting-place westwards to the handsome and convenient accommodation now afforded by the owners of the Scientific Societies' Rooms would have had the effect of considerably increasing the number on the list. Those gentlemen who are at present the members of the Society have, however, to a large extent, the matter in their own hands, and they can, the Council believe, easily add considerably to the roll of membership by inducing their friends to join. It may be said that the Society pays its way and saves money. So it does, but with an increase of income from an additional number of members much more could be done than is at present possible. The library itself is worthy of great expansion, and the typical collection of fossils which the Society many years ago began to form, might and ought to be put into a more accessible form than of late years has been the case.

The meetings of the past session were fairly attended, though on the average not more than one-fourth of the total number of members seem to have been present on any one occasion. A number of interesting and valuable papers were read and discussed, and a large variety of specimens were brought forward for exhibition and remark. Among the former may be mentioned Mr. John Horne's (of the Geological Survey) paper on "The Volcanic History of the Old Red Sandstone north of the Grampians" ; Mr.

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James Stewart of Williamwood's paper on "The Limestones in Cathcart and Eastwood Parishes"; Mr. Robert Craig's paper on "The Fossiliferous Band between the Upper and Lower Limestones in the Dalry District"; Dr. J. R. M. Robertson's paper on "The Bismuth and Stanniferous Deposits of Australia"; Dr. J. R. S. Hunter's paper on "The Geology of Bankend, Bellfield, and Coalburn, Lesmahagow"; Mr. Thomas M. Barr's paper on "The Origin and Early History of the Society"; and others by Mr. John Young, Mr. James Dairon, Mr. James Coutts, &c., which, though shorter, and in elucidation of specimens exhibited, might properly have been characterized as "papers."

The excursions of the season were as follows:—

Cathkin, 15th April, conducted by Mr. D. C. Glen, F.G.S.
East Kilbride, 29th April, by Mr. Andrew Patton, *Cor. Mem.*
Beith, 13th May, by Mr. Robert Craig, *Cor. Mem.*
Lanark and Falls of Clyde (Queen's Birthday Annual Excursion), 25th May, by Dr. J. R. S. Hunter, F.R.Ph.S.E., *Hon. Mem.*
Helensburgh Moor and Benbowie, 3rd June, by Mr. Dugald Bell, *V.P.*
Craigenglen, 17th June, by Mr. John Young, F.G.S., *V.P.*

These were all successfully carried out, and were well, and in some cases largely, attended. An extra excursion to meet the members of the Edinburgh Geological Society was arranged for Saturday, 1st July, to Braidwood, Carluke, on the invitation of Dr. John R. S. Hunter, and was extremely successful. Dr. Hunter entertained the party with lavish hospitality at his residence, Daleville, and in the course of the day he read a paper on the geology and archæology of the district. Thanks are due to all the gentlemen named who acted as conductors of the various excursions for the trouble they so kindly undertook on behalf of the Society.

The Library is now put into fair working order by the exertions of your active librarian, Mr. Joseph Sommerville, and his committee, as will be seen from the report which he will submit this evening, and it is hoped that consequently the books will be used by members to a larger extent than has for a long period been possible.

The new part of the *Transactions* is now well advanced at press, and will, it is expected, be issued in the course of a month or two. It brings the Proceedings and Papers up to the end of session 1881-82, a state of matters which is satisfactory to the Council, and it is hoped that publication will in future proceed uninterruptedly up to date.

During the session the Society has lost several friends by death. Dr. Rankin of Carluke, and more recently Mr. Slimon of Lesmahagow, both corresponding members of the Society, and both esteemed names in the geological world, have gone to swell the great majority. More need not be said here than an expression of regret by the Council at their loss, as it is proposed that extended notices shall appear in the Society's *Transactions*.

J. B. Murdoch, Hon. Sec.

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The following Report was read by the Hon. Treasurer, Mr. John Wight C.A. :—

TREASURER'S REPORT FOR 1881-82.

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|---|---|---|---|---|---|---|
| The funds of the Society last year, exclusive of Publications and Fossils were, after deducting the debts then due, . . . . . | | | | | £277 | 4 4 |
| The funds at the close of this year, exclusive as above, amount to . . . . . | | | £327 | 1 7 | | |
| Less Martinmas Rent, . . | £5 | 0 0 | | | | |
| Stationer's Account, . . | 4 | 0 5 | | | | |
| Printer's Account, . . | 5 | 15 3 | | | | |
| Do., Balance for *Transactions*, | 10 | 0 0 | | | | |
| Lithographer's Account, . | 8 | 16 3 | | | | |
| Deduct, . . . | | | 33 | 11 11 | | |
| | | | | | 293 | 9 8 |
| Remains, . . . . . | | | | | £16 | 5 4 |

—from which it will be seen that the Society has increased its stock during the financial year by £16 5s. 4d. This is satisfactory notwithstanding the fact that the increase for the immediately preceding year was a much larger sum, namely, £58 8s. But such results depend not merely on income but also on expenditure.

Your Treasurer reported last year that he had recovered 177 subscriptions, including 17 that were new, besides £1 for arrears. He acknowledges this year 164 subscriptions, including 8 that were new, besides £1 for arrears. The ordinary normal expenses were reported last year to be £26 6s. 10d., and the printing, so far as paid, only £7 15s. 3d.—in all, £34 2s. 1d. This year the normal expenses have been £32 6s. 1d., printing £57 9s. 6d., and new books £7 6s. 8d.—in all, £97 2s. 3d. The object of reporting these facts is to show that the ordinary management of the Society varies from £25 to £35 a year, the other expenses being almost wholly printing accounts, which are more or less as they happen to be incurred or to be paid.

The life membership subscriptions last year included only one—Mr. Barr—but this year they include two, Mr. Dougan and Mr. Glen.

Last year no money was received for publications sold, but this year that source of income has produced £8 0s. 7d. This helps to account for an increased stock in the face of a considerably heavier expenditure.

But there can be no question that the revenue from invested funds has contributed greatly the last few years to give stability to the income account. Writing from memory the Treasurer recalls that a good many years ago the Society was glad to record 20 or 25 new members on its roll, such years being considered very prosperous ones, but the resignations and removals were often so numerous as to neutralize the expected benefit. The Society by its income from investments is now, it may be said, absolutely sure of its 25 new members annually, because last year its income represented 13 subscriptions, this year 16, and next year the



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Treasurer has no doubt it will represent 20 or 22 subscriptions—all this besides the new memberships themselves, which amounted last year to 17 and this year to 8.

On the whole, therefore, the Treasurer has the pleasing duty of recording on this occasion, as he did last year, that the financial position of the Society is entirely favourable.

JOHN WIGHT, Hon. Treasurer.

For Abstract of Financial Statement see p. 434.

Mr. JOSEPH SOMMERVILLE then read the following :—

LIBRARIAN'S REPORT, SESSION 1881-82.

Your LIBRARIAN is glad to be able to report that the Library is now beginning to assume something like an orderly arrangement. When he accepted the office he little dreamt of the amount of work involved. But when he remembers that at that time a large quantity of unbound books and copies of the *Transactions* were located in Anderson's College some progress has undoubtedly been made.

The Library Committee appointed by the Council, consisting of Messrs. Dairon, Forsyth, Christie, and White, with Mr. Murdoch *ex officio*, rendered much valuable assistance in arranging the unbound *Proceedings* and *Transactions* of those societies with which exchanges are made. This part of the Library is still, however, far from being in a satisfactory condition. From the irregular way in which these publications have been kept it will take a considerable amount of time and trouble to put matters right.

In the beginning of the session the Society voted the sum of £20 for the purpose of purchasing new books and for binding. About £10 of this amount has been spent on new books—16 vols. having been added—and the balance has been laid out on binding upwards of 80 volumes. The binding has been exclusively confined to the publications of the English-speaking societies, a considerable number still remaining unbound, while the whole of the Continental ones still remain to be undertaken, and to keep the Library in anything like order this would require to be done before they accumulate to a much greater extent. Afterwards a small annual outlay would suffice.

A catalogue of the books is in progress, but it was deemed advisable not to hurry with it in the meantime, seeing that so many new books were being added. The books are now being all entered in a stock-book, and until a catalogue is prepared members working at any special branch would be welcome to consult it.

During the session Part II. of Vol. VI. of the *Transactions* was published and distributed to members and societies—to members 224 copies, and to societies 58 copies. The latter are classified as follows :—29 British, 17 Continental, 10 American, 1 Indian, 1 Australian. The expenses connected with the distribution of these 282 copies, all being delivered free, was £2 2s. 4d.

Of the back parts of our *Transactions* and of the "Catalogue of the Western Scottish Fossils," a considerable number were sold, the income from that source amounting to £8 0s. 7d.

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The stock of the "Catalogue of the Western Scottish Fossils," which was presented to the Society, was partly bound and partly in sheets. The bound copies having been sold out, the Council decided to bind as many complete copies as the remaining sheets would permit of. 86 copies have therefore been bound, 30 being interleaved with ruled paper for additions. The price of the latter is 3s. 6d., and that of the others 2s. 6d.

Exchanges with home and foreign societies still continue to add considerably to the Library every year, as well as donations from various institutions and friends. We received from our Vice-President, Mr. Bell, his book, "Among the Rocks round Glasgow." We also received from Mr. Glen, Lyell's "Elements of Geology," and the first volume of Lyell's "Principles of Geology."

The cases of fossils and rocks have been removed from Anderson's College and now occupy the ground floor of this building, but nothing has been done in the way of making them available for the use of members. And as the accommodation for them here is not of a suitable kind, the Council have still to consider what is best to be done with them.

JOSEPH SOMMERVILLE, Hon. Librarian.

Mr. DUGALD BELL, *V.P.*, then moved the adoption of the Reports, also that a hearty vote of thanks should be awarded to the Secretaries, Mr. J. B. Murdoch and Mr. Gavin Pratt, to the Treasurer, Mr. John Wight, and to the Librarian, Mr. Joseph Somerville, for the work they had undertaken on the Society's behalf during the past year, and which had brought about the successful commencement of another. This motion was seconded by Mr. James C. Christie and unanimously agreed to.

The vacancies amongst the office-bearers occurring at this time were then filled as follows :—

As Vice-President, Mr. David Forsyth, M.A. ; as Members of Council, Dr. Dougan, Messrs. Robert Mason, Thomas Naismith, Daniel Wilson, and John Young, F.G.S. ; as Honorary Secretary, Mr. James B. Murdoch ; as Assistant Secretary, Mr. Gavin Pratt ; as Honorary Treasurer, Mr. John Wight, C.A. ; and as Honorary Librarian, Mr. Joseph Sommerville.

Dr. J. R. S. HUNTER, *Hon. Mem.*, then read an interesting biographical notice of the late Mr. Slimon, surgeon, Lesmahagow, one of the Society's Corresponding Members lately deceased (see page 238). On its conclusion the Chairman said he thought that discussion upon the subject matter of Dr. Hunter's paper would be out of place, but that any additional reminiscences by members who knew Mr. Slimon would be welcome.

Mr. JAMES THOMSON, F.G.S., remarked that Lesmahagow was now a blank to him. Since the year before that in which the Society was founded (1858) he had been acquainted with Mr. Slimon. Much more might have been said regarding the deceased gentleman's career, but what had been said had been well said.

The CHAIRMAN (Mr. YOUNG) said he had known the subject of Dr. Hunter's paper for the past 27 years, and he could cordially agree with the remarks which had been made. Mr. Slimon was essentially a neat-handed

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man, as his specimens and the way in which they were mounted remained to testify.

Mr. FORSYTH said he could bear out what had been said as to their deceased friend's originality. On one occasion when he went up to the district, "the Doctor," as he was locally known, had a quiet joke at his "tools," and laughing at the lightness of the hammer and chisel he had brought with him, said, "Ye're no to come up pap, papping here; ye're to quarry." He thought Dr. Hunter was the right man to bring the subject before the Society, as he knew Mr. Slimon had for years looked upon him as his proper successor in working out the palæontology of the important district of Lesmahagow.

It was agreed that a motion of condolence with Mr. Slimon's widow and nearest relatives should be passed, and that an extract from the Minutes to that effect should be forwarded to them by the Secretary.

Mr. George Alexander and Mr. John Robertson were elected Auditors of Accounts for the current year.

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SOCIETY'S ROOMS, 207 BATH STREET,
7TH DECEMBER, 1882.

Mr. ARCHIBALD ROBERTSON, *Vice-President*, in the Chair.

Mr. JAMES COUTTS exhibited further remains of *Gyrolepis Rankini* and of *Cœlacanthus*, sp., from the Cement-limestone shales, East Kilbride, and in the collection of Mr. A. Patton, *Cor. Mem.*, the specimens showing jaws, teeth, scales, and portions of bone, but in a crushed condition, as is usual in the beds named. Mr. Coutts also exhibited sharks' teeth and other organisms from the English Lower Greensand—the species of sharks represented being related to the Porbeagle, Hammer-headed Shark, Saw-fish, and Eagle Ray.

Mr. JOSEPH SOMMERVILLE exhibited a beautifully striated Boulder from Hamilton Hill, Port-Dundas. It was a round septariated ironstone nodule, and had probably come from the shales near Corrieburn, where quantities of similar nodules are still to be found.

Mr. JOHN YOUNG, F.G.S., exhibited a specimen of Tourmaline Rock from Daviot, Aberdeenshire, remarking that it was often confounded with Hornblende, though distinguishable from it by its hardness and other characteristics.

Dr. J. J. DOBBIE said that he agreed with Mr. Young in saying that Tourmaline was one of the most complicated minerals known. It was really formed of several different minerals, which, though often found in combination, might have had an independent existence.

Mr. ROBERT CRAIG, Beith, *Cor. Mem.*, then read a paper entitled "Volcanic Action during the Carboniferous Period in the Dalry District." (See page 233.)

Mr. DUGALD BELL, Mr. JOHN YOUNG, and other members having spoken on various points connected with the subject of the paper, a hearty vote of thanks was passed to the author.

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SOCIETY'S ROOMS, 207 BATH STREET,
18TH JANUARY, 1883.

Mr. DUGALD BELL, *Vice-President*, in the Chair.

Mr. JOSEPH SOMMERVILLE proposed that the sum of £10 from the Society's funds should be devoted to the purposes of the library. This was seconded by Mr. D. C. Glen, and unanimously agreed to.

Professor Judd, F.G.S., London, and Dr. Robert Brown, F.G.S., &c., London, were elected Honorary Members of the Society.

Mr. David T. Maclay, 3 Woodlands Terrace, was elected a Life Member.

Mr. John Farquhar, jun., 13 Belhaven Terrace, and Mr. William Muir Ferguson, 116 St. Vincent Street, were elected Ordinary Members.

Mr. JOSEPH SOMMERVILLE exhibited specimens of *Anthracosia robusta* from the Shotts "Ball" or Furnace Coal, and compared them with specimens of what he believed to be their nearest recent analogue, *Unio tumidus*, from the neighbourhood of Bristol.

Mr. JOHN YOUNG, F.G.S., also exhibited a fine series of *Anthracosia robusta* from the Dalmellington coal-field, sent by Mr. William White, and forwarded by him for exhibition through Mr. John A. Harvie-Brown of Dunipace.

Mr. D. C. GLEN, F.G.S., exhibited several beautiful specimens of Crocidolite from Orange River, South Africa, also a large plate of Mica holding curious markings between the laminæ, caused by the growth of crystals of "Wad" or dendritic manganese.

Mr. JAMES COUTTS exhibited specimens of "Black Amber" or "Jet" from the oil shales of West Calder, and which belong to the Lower Carboniferous series.

Mr. YOUNG remarked that he had never seen similar specimens, nor had any like them been previously brought under the notice of the Society. Along with Dr. J. J. Dobbie, he had tested this mineral in various ways, and from the results he believed it to be allied closely to Albertite or Grahamite. Mr. Glen and Mr. J. C. Christie also made some remarks on the specimens.

Mr. COUTTS also exhibited specimens of *Ulodendron minor*, *Lepidodendron elegans*, *L. obovatum*, and *L. gracilis*, from the same strata.

Mr. JOHN YOUNG, F.G.S., read a paper "On the Identity of *Ceramopora megastoma*, M'Coy, with *Fistulipora minor*, M'Coy," in which he traced the gradual progression of the organism from the encrusting polyzoon to the perfect tabulate Monticulipora stage. [See page 244.]

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SOCIETY'S ROOMS, 207 BATH STREET,
15TH FEBRUARY, 1883.

Mr. DAVID FORSYTH, M.A., *Vice-President*, in the Chair.

An old hand-bill announcing a series of Geological Lectures by Mr. John Craig at the time of the first British Association Meeting in Glasgow

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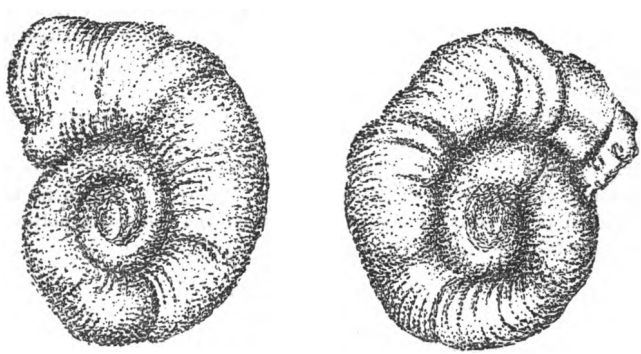
in 1840, and containing a reference to "the members of the Glasgow Geological Society," was presented to the Library of the Society by Mr. John Young, F.G.S., on behalf of the donor, Mr. John Wilson, Glasgow. Mr. Thomas Barr, C.E., said that after the most careful enquiry as to the existence of a Geological Society in the year mentioned, he had been unable to find a single allusion, or a single person who could give him any information on the subject. A copy of the hand-bill would be appended to his paper on the early history of the Society. [See vol. VII., part 1, p. 125.] Mr. Glen said that Mr. Craig was a well-known lecturer on geological subjects, and he well remembered that on an excursion to Arran in 1842 Mr. Craig described the sections as they passed along.

Mr. Thomas Scott, *Cor. Mem.*, exhibited several specimens of a shell new to science from the Post-tertiary clays of Garvel Park, Greenock, and which were found by him there in the autumn of 1882. They were submitted to Dr. J. Gwyn Jeffreys, and by him to Dr. M'Intosh, who remarked that "the specimens are probably young examples of *Spirorbis*," while Dr. Jeffreys said, "I believe it is new to science either as an Annelide or a Foraminifer. Many of the Foraminifera have an internal chamber or septa, as *Cornuspira*." Mr. Scott said that he had named the organism *Spirorbis* (*?*) *Wattianus*, as a remembrance of the many interesting remains found in the Post-pliocene clays during the formation of the James Watt Dock at Garvel Park, and submitted the following description—

*Spirorbis* (*?*) *Wattianus*, T. Scott.

Shell spiral, forming a flat coil, slightly and equally concave on both sides, not glossy, whorls 4 or 5, rounded, a little flattened on both sides, strongly and irregularly marked by growth lines, suture rather deep, mouth more or less oval according as the whorls are more or less depressed, no divisions or septa internally.



The above figures have been taken from drawings made by Mr. Rochfort Connor of Greenock, magnified 30 diameters.

Mr. Walter Burns exhibited a number of Fossils from the Upper Carboniferous Limestones, several beds of the series being recently exposed in

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the excavations for the foundations of the new Inland Revenue offices at the N.E. corner of George Square. The fossils, though not in good preservation, were interesting as a means of identification of the horizon of the strata.

Mr. DUGALD BELL, *V.P.*, exhibited with remarks a number of Fossils he had collected from the Lias and Oolite beds on a visit to Mull and Skye some years ago. The Chairman and Mr. Young also spoke, the latter observing that a great work lay before geologists in the thorough exploration of the strata Mr. Bell had referred to.

The CHAIRMAN (Mr. Forsyth) read a paper on "A Bed of Post-glacial Clay exposed by dredging in the Harbour of Girvan, Ayrshire," illustrating it with maps, sections, and specimens of fossils. [See page 251.]

The Hon. SECRETARY (Mr. Murdoch) then read a paper which had been forwarded to him by Mr. John Horne, F.G.S., of the Geological Survey, on "The Geology of the Isle of Man." [See page 254.]

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SOCIETY'S ROOMS, 207 BATH STREET,

8TH MARCH, 1883.

Mr. ARCHIBALD ROBERTSON, *Vice-President*, in the Chair.

Mr. George Brown, teacher, Free Normal School, Cowcaddens, was elected an Ordinary Member of the Society.

Mr. JAMES COUTTS exhibited two Coprolites probably of *Rhizodus Hibberti*, the largest weighing 1lb. 2¼oz., being of very unusual size.

The CHAIRMAN (Mr. Robertson) read an extract from the Proceedings of the Geological Society of London at the annual meeting on 16th February last, containing an announcement that the Council had awarded to Mr. John Young, of the Hunterian Museum, Glasgow, the balance of the proceeds of the Murchison Donation Fund, as a mark of their appreciation of the value of his long-continued researches into the Fossil Polyzoa, especially those of the Western part of Scotland, and of his investigations into the structure of the shells of the Carboniferous Brachiopoda. The Chairman further congratulated Mr. Young upon the distinguished honour conferred upon him, one which was also an honour to the Geological Society of Glasgow, and expressed a hope that he would be long spared to prosecute his studies. Mr. Young made a suitable reply.

Mr. THOMAS KING read a short paper entitled, "Notes on a recent Flood in the Desert of Atacama, North Chile," which was supplementary to one given by him to the Society several years previously. [Vol. VI. page 18.] The observations of the effects of the flood referred to by Mr. King, and which had been made by his brother, corroborated generally the conclusions he had formerly come to. [See page 262.]

J. R. S. HUNTER, LL.D., &c., then read a paper on "Three Months' Tent Life amongst the Silurian Hills of Logan Water, Lesmahagow," giving a detailed and interesting account of his last summer's sojourn under canvas, whilst engaged in investigating the strata and collecting the fossils of the district noted. [See page 272.] The paper was illustrated by an ex-

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tensive series of fossils in a splendid state of preservation, which had been laid out in the rooms at an early hour, so that members had a good opportunity of inspecting to advantage its many treasures. On the conclusion of Dr. Hunter's paper, Mr. David Forsyth, M.A., gave some further description of the physical characters of the neighbourhood. Mr. John Young, F.G.S., also spoke, remarking that the fossil remains of the Lesmahagow strata showed very different characters from those of the Wanlockhead district, the latter being of marine origin, while the former bore evidences of being laid down under brackish or fresh-water conditions, one feature being that they largely consisted of phyllopod crustaceans.

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SOCIETY'S ROOMS, 207 BATH STREET,
12TH APRIL, 1883.

Mr. DAVID FORSYTH, M.A., *Vice-President*, in the Chair.

Mr. JAMES C. CHRISTIE called attention to the section of Boulder-clay at present exposed through the operations of the Cathcart District Railway, near Myrtle Park. It showed lenticular masses of sand, with embedded fragments of coal at a considerable depth from the surface.

Mr. JAMES COUTTS exhibited a further series of Fish and Crustacean remains from the Cement-limestone series of Limekilns, East Kilbride, and in the cabinet of Mr. Andrew Patton, *Cor. Mem.*, there. Mr. Young made some remarks upon the more noteworthy specimens.

Mr. JOHN YOUNG, F.G.S., exhibited from the Lower Carboniferous red sandstone of Wemyss Bay a thin slab covered with the track casts of, apparently, an Annelid, and which, so far as appearances went, he was inclined to refer to the provisional genus *Helminthites* of Salter. The slab had been found by Mr. James Steel, who had presented it to the Hunterian Museum. The central furrow along the body of the animal and the numerous fringe-like cirri were seen most beautifully marked in these casts. So far as he was aware this was the first occurrence of this organism in the sandstones of the Clyde district.

Mr. JOHN KIRSOP exhibited a variety of specimens, including cut and polished corals from Devonshire, serpentine from Cornwall, &c., &c.

Mr. JAMES STEEL read a paper by Mr. Thomas Scott and himself, entitled "Notes on the occurrence of *Leda arctica* (Gray); *Lyonsia arenaria* (Möller), and other organic remains in the Post-pliocene Clays of Garvel Park, Greenock." [See page 279.] The paper was illustrated by a ground plan and sections, and by specimens of the fossils described.

Mr. DUGALD BELL, *V.P.*, read a paper on "The Geology of Ardrossan and East Kilbride," in which he described the interesting sections exposed beside the trappean points of Saltcoats and Ardrossan—in the one case of the neighbouring coal measures, and in the other of the Carboniferous sandstone series. North of Ardrossan the calciferous sandstones come in and occupy the eastern shore of the firth from that point to Port-Glasgow. Mr. Bell alluded to a remarkable fault and great trap dyke

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which occur at Ardneil Point, near Portincross, whereby higher beds of the calciferous sandstone series are brought down against much lower beds, accompanied by unusual disturbance of the strata. He also described the fine coast section at Goldberrie Head, and in closing referred to some of the boulders scattered over the district. [See page 342.]

Owing to the lateness of the hour any discussion on Mr. Bell's interesting paper was held over till the following meeting.

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SOCIETY'S ROOMS, 207 BATH STREET,

3RD MAY, 1883.

Mr. ARCHD. ROBERTSON, *Vice-President*, in the Chair.

Mr. Daniel G. Miller, M.A., teacher, Elgin Terrace, Dowanhill, and Mr. Robert King, ironfounder, Keppochhill Cottage, were elected Ordinary Members of the Society.

Mr. JAMES COUTTS exhibited an undetermined specimen, probably of an Arachnoid, from the Cement-limestone series, East Kilbride, and in the collection of Mr. Andrew Patton, *Cor. Mem.* Mr. John Young, F.G.S., made some descriptive remarks.

Mr. JAMES B. MURDOCH exhibited specimens of a coarse-grained felspathic volcanic agglomerate, various porphyries, and other rocks, which he had brought from the Eildon Hills, near Melrose. He remarked that these well known hills, invested with a romantic interest by the writings of the "Wizard of the North," Sir Walter Scott, though appearing as three cones, form essentially one mass, and are really of one geological character. The peaks are protrusions of porphyry through the greywacke or Cambro-silurian strata which wrap round their flanks on all sides. On the mid peak the porphyry is of a dark dull-red colour, with a few felspar crystals scattered through a felspathic base. In the northern peak it has a reddish or greenish felspathic base with felspar crystals. On the side next Bowden it forms pentangular columns. The ash beds, which form a lower hill near Melrose, are extremely interesting from the variety of their constituents. They are largely quarried for building purposes. These ash-beds or agglomerates would form good objects for microscopic sections. Mr. Young, Mr. Christie, and other members also spoke on various points connected with the subject of Mr. Murdoch's remarks.

Mr. JAMES C. CHRISTIE exhibited a curious Concretionary Nodule found embedded in coal.

Mr. JOHN YOUNG, F.G.S., exhibited a specimen and drawing of "Cockstail Sandstone," *Spirophyton cauda-galli*, Vaux, and stated that the remains of this marine fucoid had been but rarely found in the limestone strata of Western Scotland. On a recent excursion of the Society to the hillside above Milton of Campsie, it was got in abundance in a bed of sandstone in Spouthead Burn, on the Glorat estate. It occurs spread out on the rock in broad feather-like fronds, whence the name "Cockstail." On the specimen exhibited the surface of the frond was covered

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by the drifted remains of small crinoid stems, being the first occasion on which this organism has been found associated with marine remains in our limestone strata, although it has always been identified as a marine plant.

Mr. YOUNG then read a paper "On Ure's 'Millepore,' *Tabulipora Urii*, J. Young (*Cellepora Urii*, Fleming)," an encrusting and branching organism from the Carboniferous limestone of East Kilbride, first figured and described by the Rev. David Ure, in his History of Rutherglen and East Kilbride in 1793. Mr. Young described its external form and internal structure, and stated that he had recently discovered a new character in the latter, through which the organism could readily be distinguished from that more recently described by Prof. Phillips, *Calamopora tumida*, and with which form Ure's Millepore had often been confounded. [See page 264].

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SOCIETY'S ROOMS, 207 BATH STREET,
17TH MAY, 1883.

Mr. DAVID FORSYTH, M.A., *Vice-President*, in the Chair.

Mr. JOHN YOUNG, F.G.S., spoke of the recent death of Mr. Wm. Grosart, surgeon of Salzburg, parish of Shotts, *Cor. Mem.*, and proposed that a vote of condolence with his widow and near relatives should be inserted in the minutes, and an extract forwarded to them. He also suggested that a sketch of Mr. Grosart's life and work should be drawn up for publication in the *Transactions* of the Society. This was unanimously agreed to.

Mr. JAMES COUTTS exhibited a small collection of Phyllopod Crustaceans, and of various fish and plant remains, from the middle and lower limestone series of East Kilbride, some of them being of considerable interest and rarity. Dr. R. H. Traquair and Mr. Young also made some remarks on them.

Mr. EDWARD E. DODDRELL exhibited a number of fossil shells, existing only as casts, from the banks of the Tagus, in the neighbourhood of Lisbon, and Mr. Young shortly described them.

Dr. R. H. TRAQUAIR, F.R.S.E., &c., read an interesting paper on "Some New Fish Remains from the Carboniferous Rocks of the West of Scotland," in the course of which he exhibited and described specimens of *Gyrocanthus Youngi*, *Perinacanthus Craigi*, *Pœcilodus elongatus*, *Ctenodus interruptus*, and *Cheirodus corrugatus*, named by himself. The hasty drawings on the black board, by which Dr. Traquair brought out the specific points of difference in the various genera, were much appreciated by the members. After a hearty vote of thanks, Dr. Traquair was unanimously elected an Honorary Associate of the Society. [For a portion of Dr. Traquair's paper, see page 392.]

The CHAIRMAN then declared the Session closed, and the Society adjourned until the opening of the 26th Session in the ensuing October.

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# PROCEEDINGS FOR SESSION 1883-84.

## (26TH SESSION.)

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SOCIETY'S ROOMS, 207 BATH STREET,

11TH OCTOBER, 1883.

Mr. DUGALD BELL, *Vice-President*, in the Chair.

Mr. JOHN CLELAND, B.Sc., C.E., 31 Bank Street, Hillhead, was elected an Ordinary Member of the Society.

Mr. D. C. GLEN, F.G.S., who had been appointed a delegate to represent the Society at the late meeting of the British Association for the Advancement of Science at Southport, gave a short account of his visit there, and of the more noteworthy papers read in Section C; also of several of the excursions, including one to the new Mersey Tunnel Works, near Liverpool.

Mr. MURDOCH called attention to the forthcoming series of Science Lectures to be given during the winter months in St. Andrew's Hall, including one by Dr. Archibald Geikie, Director-General of the Geological Survey.

Mr. JOHN YOUNG, F.G.S., exhibited a specimen of Scyelite, a new rock compound allied to Bastite or Schiller-spar, found near Loch Scye, Caithness, and associated with a vein of Hematite. This rock is of a dark blackish-green colour, and has a rude semi-crystalline structure, the facets of the crystals glistening with a coating of numerous small scales of a talcose-looking mineral. It has been named "Scyelite" by Dr. Heddle of St. Andrews, after a small loch in the district where it is found. An analysis by Mr. H. R. Mill, of the Chemical Laboratory, University of Edinburgh, shows it to be composed of Silica, Magnesia, Ferric Oxide, Lime, Alumina, Manganite, Potash, Soda, and Water, in varying proportions. The compound forms a very peculiar looking rock, which Dr. Heddle says he has never previously seen. Whether it is of igneous origin, or is a metamorphosed sedimentary rock, Mr. Young said he was not at present in a position to say. The specimen exhibited was presented to the Hunterian Museum by Mr. James Duncan, Twechar, Kilsyth.

Mr. JOHN KIRSOP, F.S.A. Scot., exhibited specimens of large Orthoceratites from the Cement-limestone shales of East Kilbride.

Mr. JAMES WHITE read an interesting paper entitled "Random Notes on the English Lake District." [See page 334.] Mr. White's paper was illustrated by a map of the Lake Country and by specimens of the rocks.

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SOCIETY'S ROOMS, 207 BATH STREET,
8TH NOVEMBER, 1883.

Mr. DAVID FORSYTH, M.A., B.Sc., *Vice-President*, in the Chair.

Mr. MURDOCH read as follows :—

THE REPORT OF THE COUNCIL FOR THE PAST SESSION, 1882-83.

The Council have much pleasure in once more meeting the members at the beginning of another session, and in giving their report on the work of the past year. The retrospect is upon the whole satisfactory, as it shows the Society to be in an efficient working condition, while the outlook is hopeful for future work, and the financial state of matters is, as your Treasurer will tell you, a fairly prosperous one.

The MEMBERSHIP has as usual been affected by deaths and resignations, but has received, of course, a certain accession of new members. While this is so, the Council believe that, by a slight exertion on the part of individual members, the roll might be added to, as the total number can hardly be looked upon as inclusive of all those who should be members of a Geological Society in a district so largely dependent on mineral industries as the West of Scotland.

The MEETINGS of the session were nine in number, and were generally well attended, about one-fourth of the membership being the average present at each. The papers and specimens submitted contained much matter of general interest, the local character of many rendering them more than usually attractive. Amongst the papers may be named the following: —"Thoughts suggested by a Visit to Skye," by Mr. James White; "Volcanic Action during the Carboniferous Period in the Dalry District," by Mr. Robert Craig; "Notes on the Identity of *Ceramopora (Berenicea) megastoma* of M'Coy, with *Fistulipora minor* of M'Coy," by Mr. John Young, F.G.S.; "On a Bed of Post-glacial Clay exposed by dredging in Girvan Harbour," by Mr. David Forsyth, A.M., *V.P.*; "The Geology of the Isle of Man," by Mr. John Horne, F.R.S.E., F.G.S., &c.; "Three Months' Tent Life on the Silurian Hills of Logan Water, Lesmahagow," by Dr. John R. S. Hunter; "Notes on the occurrence of *Leda Arctica*, &c., at Garvel Park, Greenock," by Mr. Thomas Scott and Mr. James Steel; "Notes on the Geology of Ardrossan and West Kilbride," by Mr. Dugald Bell, *V.P.*; "On Ure's Millepore (*Cellepora Urii*, Fleming), an incrusting and branching organism from the Carboniferous Limestone of East Kilbride, first figured and described by the Rev. David Ure in his history of Rutherglen and East Kilbride in 1793," by Mr. John Young, F.G.S.; and "On some new Fish Remains from the Carboniferous Rocks of the West of Scotland," by Dr. R. H. Traquair, F.R.S.E., F.G.S., &c. Many specimens were exhibited by, amongst others, Messrs. James Coutts, J. Kirsop, D. C. Glen, Walter Burns, J. Sommerville, Dugald Bell, J. B. Murdoch, J. C. Christie, John Young, and Dr. J. R. S. Hunter, the latter gentleman bringing down from Braidwood, in illustration of his paper mentioned above, a splendid suite of Silurian Fossils. The Council would, however, draw attention to the fact that these contributions have come from a compara-

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tively small number of the Society's members, and would express the desirability of as many as possible taking part in the work. It is not well when all the burden is left upon a few shoulders, and the Council, under the belief that there is much material and many facts of interest in the possession of members, would urge them to bring forward whatever they can, with the assurance that everything bearing on the study of geology will meet with a hearty welcome.

The EXCURSIONS of the Spring and Summer months were to :—

Milton of Campsie, 21st April, conducted by Mr. D. Wilson.
Waterland, near Lugton, 5th May, by Mr. R. Craig, *Cor. Mem.*
Aberfoyle (the Queen's Birthday Excursion), 24th May, by Mr. John Kirsop.
Strathblane and Milngavie, 2nd June, by Mr. John Young, F.G.S.
Cunningham Baidland, Dalry, 16th June, by Mr. John Smith.

This latter was altered to a visit to Cleave's Cove, a bone cave on the Dusk water near Dalry, and which had been lately explored by Mr. Smith. On the occasion of the gathering he read an interesting paper, giving an account of his arduous work in the exploration of the cave, and which it is to be hoped he will give for publication in the Society's *Transactions.* [See page 284.] In addition to these a very interesting joint-excursion with the members of the Geological Society of Edinburgh, conducted by Mr. John Young, F.G.S., was made to Stirling, and a pleasant afternoon was spent, the party being met and accompanied by a number of the members of the Stirling Field Club. The thanks of the members are due to all the gentlemen who acted as conductors on these occasions. Long and interesting notices of most of these excursions appeared in the columns of the *Evening Times* and the *Weekly Herald*, from the pen of our esteemed friend the author of "The Rocks around Glasgow," and the Council hope that he will allow such portions of them as may be suitable to appear in the Society's *Transactions.*

The LIBRARY continues to receive additions from the exchanges made with many British and Foreign Scientific Societies ; a number of books being also added by purchase, as will be seen from the Librarian's report.

The TRANSACTIONS.—A new part (vol. VII. part 1) was issued during the summer. It contained the work of two years—1880-81 and 1881-82—and therefore brought up arrears to the beginning of the past session. The Council have fixed that the printing for that session—1882-83—shall be at once begun, so that no delay may prevent the issue from being brought up to date as speedily as possible. The following part will therefore contain most of the papers already mentioned in this report and those brought forward during the present session.

DEATH OF MEMBERS.—During the year just closed the Society has lost several of its members by death, notably Mr. William Grosart, surgeon, of Salzburg, a good worker in the geological field, and one who had made his mark, several valuable papers having appeared in the Society's *Transactions* for past years.

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The Hon. Treasurer (Mr. John Wight, C.A.) read as follows:—

THE TREASURER'S REPORT FOR 1882-83.

The funds of the Society last year amounted to £393 9s. 8d. after deducting the current floating debts then unpaid, but that sum included the total property of the Society other than cash, valued at £100, which has been found, on a careful valuation made lately by Mr. Sommerville, to have been too low. The valuation of the property as it exists now has just been read [see Abstract, page 437], and the net funds as at this date are £452 14s. 11d. Mr. Sommerville suggests most properly that this valuation should be revised every session.

Your Treasurer reported last year 164 subscriptions recovered, and £1 of arrears, besides 8 new members—in all 174. This year he acknowledges 149 subscriptions and £2 10s. of arrears, besides 8 new members—in all 162, showing a loss of membership to the extent of 12 subscriptions, or in value £6. But this is a trifle considering that the revenue from invested funds has yielded a sum equal to 16 members' subscriptions. Such new membership can be safely counted on every successive year, and it is one that is bound to increase.

The Life Subscription Account has been increased by £5 5s., and now amounts to £126.

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| The accounts show that the Ordinary Expenditure paid has been | | | | | £43 | 10 1 |
| To which add Ordinary Expenditure unpaid, | | | | | 14 | 2 6 |
| | | | | | £57 | 12 7 |
| Against which is Revenue recovered, | | | | | 89 | 3 8 |
| Leaving a balance to meet cost of *Transactions* of | | | | | £31 | 11 1 |
| But the *Transactions*, so far as paid, have cost | | £19 | 2 | 9 | | |
| And so far as unpaid | | 81 | 1 | 6 | | |
| Total, | | £100 | 4 | 3 | | |
| Less publications sold, | | 7 | 6 | 6 | | |
| In all, | | | | | 92 | 17 9 |
| Leaving the sum of | | | | | £61 | 6 8 |

to be paid out of capital. But of that capital there are *Transactions* in stock to the value of £50.

The result of this statement, in its simplest form, shows that the *Transactions* last year have cost £100 4s. 3d., and that ordinary revenue has provided £31 11s. 1d. of that expense; from which it appears that the balance, £68 13s. 2d., must be provided for out of capital; yet that balance may not have been the whole sum of £68 13s. 2d., because the Stock Account contains *Transactions* valued at £50, some of which may be part of last year's issue.

On the whole the Society's affairs financially are prosperous.

JOHN WIGHT, Hon. Treasurer.

[The Treasurer's Financial Abstract will be found at page 436.]

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Mr. SOMMERVILLE read his report on the Library as follows :—

REPORT OF THE LIBRARIAN FOR 1882-83.

The LIBRARIAN has much pleasure in reporting that the Library has been well taken advantage of during the past session—111 volumes having been given out—and from the increasing number of volumes being added to the shelves every year, there can be little doubt that its usefulness will also increase. There were purchased last session 27 volumes, among them some new and valuable works, including a complete set of Darwin's works. A few shillings above the £10 voted by the Society at the beginning of the session have been spent on the purposes of the Library. Large additions are also being made every year by the publications of those societies with whom exchanges are made. They are 53 in number, viz.—22 British, 17 Continental, 14 American, 1 Indian, and 1 Australian.

Professor Hull sent (through Mr. Young) his admirable book entitled "A Contribution to the Physical History of the British Isles." A number of pamphlets on geological subjects have also been presented by the authors, including Professor Rupert Jones, Dr. J. R. S. Hunter, Mr. Mellard Reade, Mr. James Thomson, Mr. John Young, &c.

Part I. of Vol. VII. of the *Transactions* was issued during the session, and was sent to members and societies—280 copies being required for the purpose—the expenses of distribution being about £3, or 2½d. each.

As would be observed from the Treasurer's statement the sale of the back parts of the *Transactions* still continues. With the proceeds of their sale last year your Librarian was able to pay all expenses connected with the Library, including delivery of the *Transactions*, carriage of parcels, postages, etc., and to hand over £2 to the Treasurer.

In concluding this report it may be suggested that the Society should aim at having in its Library a set, as complete as possible, of all that has been published relating to Scottish geology.

JOSEPH SOMMERVILLE, Hon. Librarian.

The vacancies occurring at this date in the list of office-bearers were then filled up with the result undernoted :—

As Vice-President, Mr. John Young, F.G.S. ; as Members of Council, Mr. Archibald Robertson, Mr. Daniel M'Millan, Mr. James Dairon, and Mr. James White ; as Hon. Secretary, Mr. James B. Murdoch ; as Assistant Hon. Secretary, Mr. Gavin Pratt ; as Hon. Treasurer, Mr. John Wight ; as Hon. Librarian, Mr. Joseph Sommerville ; and as Auditors of Accounts, Mr. George Alexander and Mr. John Robertson.

The following gentlemen were elected Members of the Society :—As Honorary Associate, Dr. James Geikie, Murchisonian Professor of Geology in the University of Edinburgh ; as Corresponding Member, Mr. Thomas Scott, 7 Caddlehill, Greenock ; as Ordinary Members, Mr. C. L. Dobbie, 21 Hamilton Park Terrace, Hillhead, Mr. John M'Whirr, 201 Dumbarton Road, Mr. Alex. C. M'Intyre, 99 Renfield Street, and Mr. Donald M'Phee, Central Police Court.

Dr. WILLIAM WALLACE, President of the Philosophical Society of Glasgow, then re-delivered the substance of an address which he had given

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on the previous evening to the members of the Philosophical Society, "On Crystalline Form," illustrating his remarks by many examples of the modes of crystallization. On its conclusion Dr. J. J. Dobbie proposed a vote of thanks to Dr. Wallace for his kindness in coming before the Society on short notice, remarking incidentally that the study of mineralogy was not advancing so rapidly as it ought to do, which might be attributed to a neglect of the study of the laws of crystallization. Mr. John Young, F.G.S., *V.P.*, seconded the vote of thanks, and stated that he was glad to see Dr. Wallace once more amongst the members of the Geological Society, as he used to be in olden days when their friend Mr. Struthers was amongst them. Mr. Kirsop and the Chairman (Mr. Forsyth) also spoke, and the motion was cordially agreed to.

Dr. WALLACE in returning thanks said that he hoped and believed so long an interval would not again elapse before he found himself again amongst the members of the Geological Society of Glasgow.

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SOCIETY'S ROOMS, 207 BATH STREET,

6th DECEMBER, 1883.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

The following gentlemen were elected Members of the Society :—As Corresponding Members, Professor G. Lindström, Stockholm, Sweden; Rear-Admiral Bedford, Paignton, Torquay; and Mr. W. Anderson Smith, Ledaig, Argyllshire. As an Ordinary Member, Mr. Andrew Laird, mining engineer, St. Vincent Street.

The CHAIRMAN (Mr. Young) exhibited a slab of Hippurite Limestone, containing shells of the genus *Caprinella*, from Portugal, and gave an interesting account of this remarkable group of bivalves. He also exhibited a slab of Steatite with nummulites, from Lai Chow, Foo Shantung, China, a rock which he described as metamorphosed from a true limestone into its present condition.

Mr. JOHN KIRSOP exhibited a curious specimen of an Agate, the concentric layers having become largely detached from one another.

Mr. JAMES COUTTS exhibited specimens of *Sanguinolites iridinoides* and *Nautilus tuberosus* from the collection of Mr. Andrew Patton, East Kilbride. Mr. Coutts also exhibited a number of species of Goniatites, as follows :—*G. Gilbertsoni*, *G. Looneyi*, *G. micronotus*, *G. excavatus*, *G. mutabilis*, *G. implicatus*, *G. striolatus*, *G. vesica*, and *G. sphæricus*.

The CHAIRMAN (Mr. John Young, F.G.S.) read a paper entitled "Note on *Favosites* (?) (*Calamopora*) *dentifera*, Phillips." [See p. 369.] The paper was accompanied by illustrative specimens.

Mr. DUGALD BELL, *V.P.*, read a paper entitled "Geological Notes from the Land of Lorne," in which he described the rock-formations seen in the neighbourhood of Oban, and also the granitic tract surrounding the upper

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part of Loch Etive, including Ben Cruachan. He then referred to the glacial phenomena of the district, and particularly to the remarkable series of mounds observable in Glen Strae and the other glens extending from the head of Loch Awe.

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SOCIETY'S ROOMS, 207 BATH STREET,

10th JANUARY, 1884.

Mr. DAVID FORSYTH, M.A., B.Sc., *Vice-President*, in the Chair.

The following gentlemen were elected Members of the Society :—As Life Members:—Mr. Charles Lizars Dobbie, 21 Hamilton Park Terrace, Hillhead; Mr. Robert Townsend, manufacturing chemist, 128 Bishop Street, Port-Dundas; Mr. Alexander Watson Townsend, manufacturing chemist, 128 Bishop Street, Port-Dundas; and Mr. Robert Dunlop, 14 South Bridge Street, Airdrie.

The CHAIRMAN called the attention of the meeting to the Microscope on the table, presented to the Society by Bailie John Farquhar, and asked a hearty vote of thanks to be awarded to the generous donor, which was cordially agreed to. The microscope, which was a handsome one, and apparently well suited for practical use, was specially made for petrological purposes by Messrs. Swift & Son of London. Bailie Farquhar, who was present, in returning thanks, stated that he had intended the presentation of the microscope as a small token of his expression of the benefits he had derived from his connection with the Society. He had attended many of its meetings and excursions with both pleasure and profit.

Mr. THOMAS SCOTT, Corresponding Member, Greenock, exhibited specimens of an Arctic shell—*Rissoa arenaria*, Mighels and Adams, from the Post-pliocene clay-beds of Garvel Park, Greenock, and explained the horizon and distribution of this rare form in this country.

Mr. DUGALD BELL gave a *resumé* of his paper read at last meeting, on the "Geology of the Land of Lorne," and pointed out the uncertainty which had prevailed amongst geologists as to the true age and position of the Sandstone and Conglomerates in the neighbourhood of Oban. He said he was aware that these had latterly been assigned to the Old Red Sandstone, but he thought that further proof was required. With regard to the distribution of the boulders over the district, while admitting that some may have been drifted inwards from the west during a period of partial submergence, he believed by far the greater number proceeded from the adjacent mountainous tracts to the east and north. He did not believe in a glaciation of the country from the north-west or any other single direction by the agency of icebergs carried along by currents, but thought a radiation of the ice, as land-ice, on all sides, from the mountain nucleus of the country, was much more probable and more in accordance with facts. There followed an interesting discussion, which was taken part in by Messrs. Wm. Jolly, F.G.S., John Young, F.G.S., *V.P.*, James Thomson, F.G.S., and the Chairman.



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SOCIETY'S ROOMS, 207 BATH STREET,

14th FEBRUARY, 1884.

Mr. DUGALD BELL, *Vice-President*, in the Chair.

The following gentlemen were elected Ordinary Members of the Society: Mr. William Jolly, F.G.S., F.R.S.E., &c., one of H.M. Inspectors of Schools, Pollokshields, and Mr. Robert Steele, 8 Regent Park Terrace.

Mr. JOHN KIRSOP, F.S.A.Scot., exhibited a large Calcareous nodule from Lincoln, enclosing remains of fossil ammonites of various species, and presented by Dr. Henry Muirhead of Cambuslang to the Kelvingrove Museum; also a number of polished specimens of Quartz Crocidolite from Orange River, South Africa.

Mr. THOMAS NAISMITH exhibited a fine specimen of crystallized White Fluor Spar in combination with Iron Pyrites from the Laxey Lead Mines, Isle of Man.

Mr. JAMES COUTTS read a paper by Mr. Andrew Patton, Corresponding Member, East Kilbride, entitled "Geological Observations in the Parish of East Kilbride, Lanarkshire, with a list of Fossils compiled by James Coutts." In the course of his paper, Mr. Patton, who has been identified with Limestone mining in the district for upwards of fifty years, explained the position of the various beds worked for economic purposes, and the adjacent strata. [See page 309.]

Mr. JOHN YOUNG, F.G.S., *V.P.*, read a joint paper by himself and Mr. D. C. Glen, F.G.S., "Notes on the Spherulite Rock of Corriegills, and the Banded Pitchstone of Invercloy, Arran." [See page 352.]

The paper was illustrated by specimens of the rocks described, some being shown in transparent sections under the Society's microscope.

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SOCIETY'S ROOMS, 207 BATH STREET,

13th MARCH, 1884.

Mr. JOHN YOUNG, F.G.S., *Vice-President*, in the Chair.

The CHAIRMAN referred in feeling terms, to the death on the 12th instant, of Mr. John Dougan, surgeon, a Member of Council, and long a member of the Society. He then called upon Mr. DAVID FORSYTH, M.A., *V.P.*, who moved that a vote of condolence with Dr. Dougan's widow and near relations should be passed, and that the Secretary should send Mrs. Dougan an extract from the minutes. Mr. Forsyth said that their late friend was a man of fine intellect, and one who had done a considerable amount of good work in his day. He had joined the Society in 1860, and both he and Mrs. Dougan had been regular attendants at the meetings of the Society, held in Anderson's College, for many years. The motion was seconded by the Chairman, and unanimously agreed to.

Mr. D. C. GLEN, F.G.S., proposed that a short notice of Mr. Dougan's life should be drawn up for insertion in the *Transactions*.

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The following gentlemen were elected Ordinary Members of the Society:—Messrs. William M'Conochie, Plains, by Airdrie; James Prentice, Stanrigg Collieries, Airdrie; Archibald A. Young, 13 Parkgrove Terrace; and James Edmiston, 297 Argyle Street.

The Hon. Librarian, Mr. JOSEPH SOMMERVILLE, announced the gift of a number of volumes by the Geological and Geographical Surveys of the United States, one in folio, entirely of coloured plates, and was requested to thank the donors on behalf of the Society. Some of the members spoke of the great liberality shown by the U.S. Government, not only in the publication, but also in the presentation of the extensive literature connected with the Surveys of their country, contrasting it with the niggardliness displayed by the Government of this country in such matters.

Mr. JOHN KIRSOP, F.S.A. Scot., exhibited a specimen of volcanic dust, collected immediately after the eruption at Krakatoa, in the Straits of Sunda, which took place on the 28th of August, 1883. It had been kindly sent for exhibition by the Rev. Dr. Hately Waddell, accompanied by the following remarks:—"If you think the accompanying specimen of volcanic dust from Krakatoa will be of any interest to the Geological Society, it will give me much pleasure to know that you have presented it in my name. I received it from my friend Mr. J. Y. Meiklem, a grandson of the late Professor Meiklem, of the Natural Philosophy Chair in our University. He had been visiting a friend at Batavia immediately after the eruption, and although not an actual eye-witness, brought home the specimen as a memorial of the wonderful event which had occurred just before his arrival. The dust was swept from the doorstep of the office, or go-down, in which he was then transacting business. Not being a professional chemist myself I do not pretend to characterize the specimen, but from its strong resemblance to the dust which may be collected on a summer's day from a clean well-macadamized road, I am much inclined to believe that it consists of whinstone or granite rock pulverized by continuous intense heat. The dreadful event itself has been, as we know, a good deal exaggerated by rumour, but it is certain that the dust—such as that now presented—rose in such dense masses as to darken the sun for hours, and fell on the surface of the sea for hundreds of miles so thickly as to render navigation almost impossible. It covered the shores of the adjacent island of Java at the distance of 180 or 200 miles so deeply that it had to be shovelled from the streets and doorways before traffic could be resumed. Of the other terrible concomitant phenomena—the ocean wave, and the earthquake, with the consequent loss of life and submergence of towns and villages—I need say nothing now; but I may state that the detonations of the explosion were so distinctly heard at Singapore, nearly 500 miles off, that my son, who happened to be there at the time, informed us that the people imagined them to be from some heavy-gun bombardment in the neighbourhood, and sent spies to the tops of the highest buildings in the town to look out for the approaching enemy, and it was not till a telegram reached them that they were satisfied as to the real facts of the case. Notwith-

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standing all this, however, the event itself does not seem to have been greater, or the consequences more disastrous, than at the eruption of Mount Tomboro, in the adjoining island of Sumbawa, which occurred in 1815. According to Sir Charles Lyell, quoting from Sir Stamford Raffles' account, 'it began on the 5th April, and was most violent on the 11th and 12th, and did not entirely cease till July. The sound of the explosions was heard in Sumatra, at the distance of 970 geographical miles in a direct line; and at Ternate, in an opposite direction, at the distance of 720 miles. Out of a population of 12,000 only 26 individuals survived on the island. Violent whirlwinds carried up men, horses, cattle, and whatever else came under their influence into the air, tore up the largest trees by the roots, and covered the whole sea with floating timber. Great tracts of land were covered by lava, several streams of which issuing from the crater of the Tomboro mountain reached the sea. So heavy was the fall of ashes that they broke into the President's house at Beima, 40 miles east of the volcano, and rendered it, as well as many other dwellings in the town, uninhabitable. On the Java side ashes were carried to the distance of 300 miles, and 217 towards Celebes, in sufficient quantity to darken the air. The floating cinders to the westward of Sumatra formed, on the 12th of April, a mass 2 feet thick and several miles in extent, through which ships with difficulty forced their way. The darkness occasioned in the daytime by the ashes in Java was so profound that nothing equal to it was ever witnessed in the darkest night. Although this volcanic dust when it fell was an impalpable powder, it was of considerable weight when compressed, a pint of it weighing 12¾ ounces. Along the seacoast of Sumbawa and the adjacent isles the sea rose suddenly to the height of from 2 to 12 feet, a great wave rushing up the estuaries, and then suddenly subsiding. Although the wind at Beima was still during the whole time, the sea rolled in upon the shore, and filled the lower parts of the houses with water a foot deep. Every prow and boat was forced from the anchorage and driven in shore.' All this resembles much the eruption of Krakatoa. The whole of that archipelago indeed seems to be one vast dislocated and yet connected mass of volcanoes. In Java itself from end to end they are numerous; according to Lyell not fewer than 24, and I may be forgiven perhaps for mentioning that the Bromo Mount in the neighbourhood of Sourabaya, which has been slumbering now for about a century, was sometime ago minutely surveyed by my son, who not only ascended the mountain, but walked entirely round the edge of the burning crater, from which the sulphurous fumes were issuing, he being only the second European who had ever accomplished such a feat. Other friends have since made the same experiment, but he, at least, I hope will not try it again."

Mr. KIRSOP also exhibited a specimen of dust which fell in the West of Scotland on Saturday morning, 1st March last [1884]. It has been recorded as having fallen at Largs, Dunoon, Kilcreggan, Helensburgh, Lochlomondside, Kippen, and Hamilton. The specimen exhibited was forwarded by Mr. Louis P. Muirhead, Portkil, Kilcreggan, with the following remarks: —"On the day specified, when the snow fell it was quite white, but at

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9.30 a.m. it had assumed a sooty appearance. The day was quite clear about the time the dust must have fallen, and it only penetrated the snow half-an-inch. In a field sloping to the SW., about 200 feet above sea level, I measured a square foot, and transferred as nearly as possible half the amount of snow into two bowls, half into each. After evaporating the snow thoroughly, drying and weighing the residue from each, I found one yielded 1⅞ grains, and the other 2⅛ grains, or 4 grains to the square foot, being exactly 7 tons 2 cwt. 26 lbs. to the square mile. I can vouch personally for its having fallen over the Roseneath peninsula, as I walked through the snow as far north as Coulport, and heard of it there as being noticed further north still, so that at least 100 tons of it had fallen in this district alone. Taking Kippen in the north, Largs in the south, Hamilton in the east, and Dunoon in the west, as representing an area, in round numbers, of 800 square miles, these being the districts over which we find the coloured snow was seen, and admitting that four grains per square foot was a fair sample of the whole, we have here the astonishing aggregate fall of about 5,760 tons. Saturday's snowfall averaged 5½ inches. On Monday 8 inches fell, and at midnight there was another slight fall of the dust. Again the sky was clear, but it fell in little black flakes, which melted their way through the snow, leaving holes about the diameter of crow-quills. At the time it was a dead calm here, any tendency the air had to direction being from the SE. One of the older inhabitants remembers a similar occurrence in 1828, on the 20th and 22nd March, when the snow fell black. On Saturday, March 1st, the barometer showed 30·05 and the thermometer 40 degs. at 12 noon. On Monday, March 3rd, the barometer showed 29·6 and the thermometer 42 degs. at midnight, the tendency of the air on both observations being from the SE. On Monday the barometer rose at 2 P.M. to 29·4."

A specimen was submitted to Professor Judd, the well-known geologist, who reported that "the material is almost all of inorganic origin, and is not affected by boiling nitric acid. Some particles are taken up by a magnet and prove to be magnetic, but after applying the most delicate known test I could find no evidence of metallic iron. Under the microscope the following materials were detected :—Quartz with liquid enclosures and spontaneously moving bubbles, felspar (orthoclase), mica, horn blende, garnet (?), iolite (?). From the results I am inclined to think that the material has been taken up by the winds passing over mountainous regions, some perhaps as distant as Norway."

Of particles of volcanic matter there appeared no traces whatever, and this disposes apparently of the volcanic theory. Widmannstatt, in experimenting on masses of meteoric iron, found that while nitric acid acted unequally upon different portions of the surface, developing a series of lines crossing each other in three directions, narrow bands between them retained their polish and resisted the acid. These bands contain more nickel than the rest of the mass. Now small particles giving yellowish metallic reflections can be detected moving under the influence of a magnet, for what Professor Judd says regarding the nitric acid in magnetic tests agrees

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very closely with Widmannstatt. If these particles prove to be nickeliferous iron, then we may conclude that the phenomena of the coloured iron is due to planetary dust, the crystalline matter foreign to this theory being accidental, due perhaps to the winds from mountainous regions, or picked up from the earth with the snow when it was gathered.

Mr. JAMES F. STEWART wrote from Kippen that none of the snow had been collected before the thaw set in. Many persons had, however, observed the change in the appearance of the snow, and he himself could not believe his eyes, thinking it was an optical delusion or had been caused by the smoke from the village chimneys. The discolouration extended for about an inch downwards. Mr. JAMES LUMSDEN of Arden, made similar observations on Lochlomondside, and Mr. HENDERSON, at Wemyss Castle, noted similar appearances in his locality.

Should any similar downfall again take place in the West of Scotland, it is to be hoped that many observers will secure portions of the dust for analysis, so that there may be a decision as to its origin.

Mr. JAMES STEEL exhibited a specimen of *Poterioceras cordiforme* from High Blantyre, a rare fossil, this being the fourth recorded example from the West of Scotland.

Mr. DAVID FORSYTH, M.A., *V.P.*, read a paper on "The Silurian Rocks of the Girvan District," giving first a general view of the neighbourhood, and following with a more detailed description of the Craighead, Drummuck, and Mulloch areas. [See page 358.] The paper was illustrated by maps, sections, rock specimens, and fossils. Some remarks were made by members.

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SOCIETY'S ROOMS, 207 BATH STREET,
10TH APRIL, 1884.

Mr. DAVID FORSYTH, M.A., B.Sc., *Vice-President*, in the Chair.

The following gentlemen were elected members of the Society:—As Corresponding Member, Dr. Alfred Gabriel Nathorst, State Geological Survey Office, Stockholm, Sweden; as Ordinary Members, Mr. John Fowler, Kelburn Bank Terrace, and Mr. Allan Marquis, 68 Gordon Street.

Mr. JOHN YOUNG, F.G.S., *V.P.*, exhibited his collection of Carboniferous Fossil Sponge remains from the limestone strata of the Ayrshire Coalfield, re-named and re-arranged in accordance with the revised list given by Dr. G. Jennings Hinde, F.G.S., in the new illustrated "Catalogue of British Fossil Sponges" which he had recently prepared for the authorities of the British Museum, and to whom palæontologists are indebted for former papers on "Fossil Sponges," as well as for others on "Annelid Jaws," and the organisms termed "Conodonts." In the work above referred to, the Sponge remains from the Ayrshire Carboniferous limestones are placed under four orders, seven genera, and eleven species, as follows:—

1st Order—MONACTINELLIDÆ.

*Reneira (?) Carteri*, Hinde, sp.
*Haplistion Armstrongi*, Young and Young, sp.
,, *fractum*, Hinde, sp.

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2nd Order—TETRACTINELLIDÆ.

*Geodia (?) antiqua*, Hinde, sp.
*Pachastrella vetusta*, Hinde, sp.

3rd Order—LITHISTIDÆ.

*Doryderma Dalryense*, Hinde, sp.

4th Order—HEXACTINELLIDÆ.

*Hyalostelia Smithii*, Young and Young, sp.
,, *parallela*, M'Coy, sp.
*Holasterella conferta*, Carter, sp.
,, *Youngi*, Hinde, sp.
,, *Benniei*, Hinde, sp.

The remains of the Ayrshire Carboniferous Sponges as now known consist of spicules of the skeleton, and are of various beautiful forms. They are often met with in fine preservation as detached spicules in the weathered limestones. Although eight years had elapsed since the first discovery of these interesting forms in the Ayrshire limestones by Mr. John Smith, a member of the Society, they have only been recorded since then as found at one other locality in the British Islands, viz., at Ben Bulben, near Sligo in Ireland, where however they do not seem to be so abundant, or to be in such fine preservation as in Ayrshire.

Mr. JAMES COUTTS exhibited several specimens from the Cement-limestone series of East Kilbride, and in the collection of Mr. Andrew Patton, *Cor. Mem.*, including *Poterioceras cordiforme*, a species of *Actinoceras* probably new, and others.

Mr. ARTHUR MACCONOCHIE, one of the collectors to the Geological Survey of Scotland, was then introduced by the Chairman, and read a paper entitled, "A Review of the Southern Silurian Question." [For a summary see page 370.] The paper was illustrated by maps, sections, and speci mens. On its conclusion the Chairman (Mr. Forsyth) made some remarks on the subject and stated that the true reading probably lay between the conflicting views of the Survey officers and those of Prof. Lapworth, although he thought that in some respects the author had hardly done full justice to the conclusions come to and expressed by the latter observer. Mr. Young and other members also spoke, and a hearty vote of thanks was passed to Mr. Macconochie for coming through from Edinburgh to read his paper to the Society.

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SOCIETY'S ROOMS, 207 BATH STREET,

8TH MAY, 1884.

Mr. DUGALD BELL, *Vice-President*, in the Chair.

The HON. SECRETARY (Mr. Murdoch) explained that the Council had been considering for some time the best mode of utilizing the Society's collection of specimens of Rocks and Fossils now lying in the ground flat of

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their meeting-place at 207 Bath Street, and had come to the conclusion that it should be placed in the Kelvingrove Museum, where it could be generally available. They had therefore agreed to give notice to-night of the following motion :—"That the Collection of Rocks and Fossils, with the cases now in possession of the Society, shall be transferred to the Parks and Galleries Committee of the Town Council of Glasgow for exhibition in the Kelvingrove Museum." Mr. James Thomson, F.G.S., gave notice of a counter-motion.

Mr. JAMES COUTTS exhibited a number of small spherical vitrified bodies taken from an American Tertiary deposit, and a number of fish vertebræ and teeth, and mammalian bones, from the same bed. It was suggested that the former objects were of volcanic origin, but Mr. Young was inclined to believe that they were an artificial production.

Mr. ANDREW YOUNG exhibited specimens of Thomsonite from the rock cuttings of the Glasgow & South-Western Railway above Port-Glasgow.

Mr. THOMAS SCOTT, *Cor. Mem.*, Greenock, read a paper entitled "Some Notes on a Fossiliferous Shale, a little below the Cloch Lighthouse." (See page 402.)

Mr. W. ANDERSON SMITH, *Cor. Mem.*, Ledaig, Argyllshire, read a paper entitled "Preliminary Investigation into the Geology of Benderloch, with special reference to the carried boulders." A large series of beautiful water-colour sketches by the author, showing the shape and position of many of the boulders referred to, was placed upon the walls.

The Chairman (Mr. Bell), Mr. Wm. Jolly, F.G.S., and other members spoke upon the subject of the paper, but stated that they could not in some points agree with the conclusions the author had arrived at. The Society was, however, congratulated upon his accession as an observer in the geological field, and a hearty vote of thanks was passed to him for his paper, and for the fine series of illustrations which accompanied it.

SOCIETY'S ROOMS, 207 BATH STREET,
29TH MAY, 1884.

MR. DAVID FORSYTH, M.A., B.Sc., *Vice-President*, in the Chair.

The HON. SECRETARY (Mr. Murdoch) read the motion of which, on behalf of the Council, he had given notice at the previous meeting, regarding the disposal of the Society's collection of specimens, and read a draft of the conditions under which it was proposed to be handed over to the Parks and Galleries Committee. The Secretary also read a letter sent by Mr. James Thomson, F.G.S., objecting to the proposed arrangement being carried out, and regretting that he was not able from business engagements to be present at the meeting.

It was ruled by the meeting that Mr. Thomson not being present his amendment could not be put, and it consequently fell to the ground.

Mr. JAMES DAIRON, F.G.S., read a statement, and moved that the proposed arrangement be not carried out, but that the collection should be

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retained and arranged, and that a cabinet should be provided and placed in the room of meeting, so that the specimens might be available for the use of members. This was seconded by Mr. C. L. Dobbie. Mr. Arch. Robertson and others spoke in support of the original motion.

Mr. JOSEPH SOMMERVILLE moved that a committee should be appointed to examine the collection, and generally to report upon the question as to whether it could be made available for the use of members. This was seconded by Dr. J. J. Dobbie, and unanimously agreed to.

The committee was then appointed as follows :—Messrs. Rhind, Dairon, Glen, Thomson, Kirsop—Mr. Dairon, convener.

Dr. J. R. S. HUNTER, of Daleville, *Hon. Mem.*, read a long and interesting paper entitled "The Silurian Districts of Leadhills and Wanlockhead, and their Early and Recent Mining History." [See page 373.] The paper was illustrated by many specimens of the ores and rocks, also implements used by the old miners, and other objects of interest.

A portrait of the late Mr. John Dougan, surgeon, was presented to the Society by his son, Mr. Dougan, on behalf of the family, the gift being cordially welcomed by the meeting.

The Society then adjourned to the beginning of the 27th session in October proximo.

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## *Abstract of the Treasurer's Accounts for the Year ending 30th September, 1882.*

### CASH ACCOUNT.

#### RECEIPTS.

| | | | | | |
|---|---|---|---|---|---|
| Balances—Due by Treasurer at close of last Account, | £1 | 12 | 7 | | |
| Due by Librarian at do., | 1 | 10 | 10 | | |
| | | | | £3 | 3 5 |
| Annual Subscriptions— | | | | | |
| Arrears for 1880-81, | £1 | 0 | 0 | | |
| For current year, 156 at 10s., | 78 | 0 | 0 | | |
| New Members, 8 at 10s., | 4 | 0 | 0 | | |
| | | | | 83 | 0 0 |
| Life Membership Subscriptions, 2 at £5 5s., | | | | 10 | 10 0 |
| Interest—On Bank Account, | £3 | 19 | 5 | | |
| On Loan to Glasgow Corporation, | 3 | 18 | 4 | | |
| | | | | 7 | 17 9 |
| Publications Sold, | | | | 8 | 0 7 |
| Proceeds of Old Benches, | | | | 7 | 8 0 |
| Drawn from Bank, | | | | 128 | 8 2 |
| | | | | £248 | 7 11 |

#### DISBURSEMENTS.

| | | | | | |
|---|---|---|---|---|---|
| Printing *Transactions*, | | | | £45 | 0 0 |
| Books added to Library, | | | | 7 | 6 6 |
| Printing Cards, Circulars, and Receipt Book, | | | | 12 | 9 7 |
| Rent and Insurance, | | | | 10 | 11 6 |
| Collector's Commission, Postages, and Petty Expenses, | | | | 4 | 9 9 |
| Expense of distributing *Transactions*, | | | | 2 | 2 4 |
| Carriage of Parcels, | | | | 1 | 17 3 |
| Disbursements by Secretary, | | | | 5 | 18 2 |
| Do. by Librarian, | | | | 1 | 0 4 |
| Removal of Books and Cases to New Rooms, | | | | 1 | 2 6 |
| Painting Bookcase, | | | | 2 | 1 3 |
| Subscription to Palæontographical Society for 3 years, | | | | 3 | 3 0 |
| Lodged in Bank, | | | | 147 | 7 7 |
| Balances—Due by Treasurer, | £3 | 0 | 4 | | |
| Due by Librarian, | 0 | 17 | 9 | | |
| | | | | 3 | 18 1 |
| | | | | £248 | 7 11 |

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ABSTRACT OF TREASURER'S ACCOUNTS—*Continued.*

## STOCK.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| To Current Liabilities, | | | £33 | 11 | 11 | | |
| ,, Balance to Credit, | | | 393 | 9 | 8 | | |
| | | | £427 | 1 | 7 | | |
| By Cash lent to the Corporation of Glasgow, | | | | | | £100 | 0 0 |
| ,, Cash in British Linen Co. Bank— | | | | | | | |
| On Deposit Receipt, | | £147 | 1 | 2 | | | |
| On Current Account, | | 46 | 18 | 3 | | | |
| | | | | | | 193 | 19 5 |
| ,, Cash in hand—Treasurer, | | £3 | 0 | 4 | | | |
| Librarian, | | 0 | 17 | 9 | | | |
| | | | | | | 3 | 18 1 |
| ,, New Books and Bookcase, | | | | | | 29 | 4 1 |
| ,, Publications, Fossils, and Casts, | | | | | | 100 | 0 0 |
| | | | | | | £427 | 1 7 |

## LIFE SUBSCRIPTION ACCOUNT.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1882—September 30.—To Balance, | | | £120 | 15 | 0 | | |
| | | | £120 | 15 | 0 | | |
| 1881—October 1.—By Balance, | | | | | | £110 | 5 0 |
| ,, 13.— ,, J. Dougan, | | | | | | 5 | 5 0 |
| November 10.— ,, D. Corse Glen, | | | | | | 5 | 5 0 |
| | | | | | | £120 | 15 0 |

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# Abstract of Treasurer's Accounts for the Year Ending 30th September, 1883.

## CASH ACCOUNT.

### RECEIPTS.

| | | | | | | |
|---|---|---|---|---|---|---|
| Balances—Due by Treasurer at close of last Account, | | | £3 | 0 | 4 | |
| Due by Librarian, | | | 0 | 17 | 9 | |
| | | | | | | £3 18 1 |
| Subscriptions— | | | | | | |
| Arrears for 1880-81 and 1881-82, | | | £2 | 10 | 0 | |
| Current Year, 149 at 10s., | | | 74 | 10 | 0 | |
| New Members, 8 at 10s., | | | 4 | 0 | 0 | |
| | | | | | | 81 0 0 |
| Life Subscription—D. T. Maclay, Esq., | | | | | | 5 5 0 |
| Interest—On Bank Account, | | | £1 | 8 | 0 | |
| On Invested Loans, | | | 6 | 15 | 8 | |
| | | | | | | 8 3 8 |
| Stock Sold—Publications, | | | £6 | 6 | 6 | |
| Furniture, | | | 1 | 0 | 0 | |
| | | | | | | 7 6 6 |
| Stock Realized—Loan to Corporation of Glasgow, | | | | | | 100 0 0 |
| Bank Account—Drawn, | | | | | | 217 5 3 |
| | | | | | | £422 18 6 |

### EXPENDITURE.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Transactions*:— | | | | | | |
| Printing Part II. of Vol. VI., | | | £5 | 15 | 6 | |
| Lithographing and Engraving, | | | 9 | 7 | 3 | |
| Paper for *Transactions*, | | | 4 | 0 | 0 | |
| | | | | | | £19 2 9 |
| Ordinary Expenditure— | | | | | | |
| Printing Cards, Circulars, Receipts, etc., | | | £7 | 1 | 3 | |
| Rent, Insurance, and Attendance, | | | 14 | 11 | 6 | |
| Collector's Commission, Postages and Petty Expenses, | | | 5 | 7 | 6 | |
| Distributing *Transactions*, | | | 2 | 19 | 6 | |
| Carriage of Parcels, | | | 1 | 2 | 7 | |
| Disbursements by Secretaries, | | | 8 | 14 | 1 | |
| Disbursements by Librarian, | | | 0 | 11 | 2 | |
| Repairs on Cases, | | | 1 | 11 | 0 | |
| Subscription to Palæontographical Society, | | | 1 | 1 | 0 | |
| Subscription for Geological Record, | | | 0 | 10 | 6 | |
| | | | | | | 43 10 1 |
| Stock Invested—Loan to Corporation of Campbeltown, | | | | | | 250 0 0 |
| Bank Account—Lodged, | | | | | | 79 5 10 |
| Library—Purchase of Books, | | | £14 | 19 | 4 | |
| Binding Books, | | | 14 | 1 | 7 | |
| | | | | | | 29 0 11 |
| Balance—Due by Treasurer, | | | | | | 1 18 11 |
| | | | | | | £422 18 6 |

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## ABSTRACT OF TREASURER'S ACCOUNTS—*Continued.*

### STOCK ACCOUNT.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| To Current Unpaid Liabilities— | | | | By Funds Invested— | | | |
| Printing *Transactions*, | £72 | 13 | 0 | ,, Loan to Corpn. of Campbeltown, | £250 | 0 | 0 |
| Lithographing, | 8 | 8 | 6 | ,, Cash in Bank on Deposit, | 56 | 0 | 0 |
| | £81 | 1 | 6 | | | | £306 0 0 |
| General Printing, | 13 | 0 | 0 | ,, Cash in Treasurer's hands, | | | 1 18 11 |
| General Stationery, | 1 | 2 | 6 | ,, Books in the Library, | | | 150 0 0 |
| | | | £95 4 0 | ,, Transactions in hand, | | | 50 0 0 |
| ,, Balance to Credit, | | | 452 14 11 | ,, Furniture, | | | 22 0 0 |
| | | | | ,, Fossils, | | | 18 0 0 |
| | | | £547 18 11 | | | | £547 18 11 |

### LIFE SUBSCRIPTION ACCOUNT.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1883—September 30th.—To Balance to Credit, | £126 | 0 | 0 | 1882—October 1.—By Balance, | £120 | 15 | 0 |
| | | | | 1883—February 27.—,, D. T. Maclay, | 5 | 5 | 0 |
| | £126 | 0 | 0 | | £126 | 0 | 0 |

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# *OFFICE-BEARERS FOR SESSION* 1884-85.

**President**—SIR WILLIAM THOMSON, LL.D., F.R.S., &c.

**Vice-Presidents.**

| *For Three Years.* | *For Two Years.* | *For One Year.* |
|---|---|---|
| Mr. D. C. GLEN, F.G.S. | Mr. JOHN YOUNG, F.G.S. | Mr. D. FORSYTH, M.A., B.Sc. |

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| Mr. WILLIAM ARMOUR. | Mr. DANIEL M'MILLAN. | Mr. ROBERT MASON, F.L.S. |
| Mr. JOHN M. CAMPBELL. | Mr. JAMES DAIRON, F.G.S. | Mr. THOMAS NAISMITH. |
| Mr. JAMES ANDERSON. | Mr. MATTHEW BLAIR. | Mr. DANIEL WILSON. |

**Hon. Treasurer**—MR. JOHN WIGHT, C.A., 150 Hope Street.

**Hon. Librarian**—MR. JAMES WHITE, 56 Rose Street, Garnethill.

**Hon. Secretary and Editor of** *Transactions*—MR. JAMES B. MURDOCH, Barclay, Langside.

**Assistant Hon. Secretary**—MR. GAVIN M. PRATT, 104 West Graham Street.

**Publishing Committee.**

| | | |
|---|---|---|
| Mr. JOHN YOUNG. | Mr. DAVID FORSYTH. | Mr. GAVIN M. PRATT. |
| Mr. D. C. GLEN. | Mr. DUGALD BELL. | Mr. J. B. MURDOCH, *Convener.* |

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|---|---|
| Mr. ARCHIBALD ROBERTSON. | Mr. ROBERT MASON. |
| Mr. D. M'MILLAN. | Mr. J. WIGHT, *Convener.* |

**Auditors.**

Mr. GEORGE R. ALEXANDER. | Mr. JOHN ROBERTSON.

# *LIST OF MEMBERS on 30th March,* 1885.

## Honorary Members.

Year of Entry.

1859. Davidson, Thomas, F.R.S., F.G.S., 9 Salisbury Road, Brighton.
1865. Geikie, Archibald, F.R.S., F.G.S., Director-General of the Geological Survey of Great Britain and Ireland, London.
1867. Jones, T. Rupert, F.R.S., F.G.S., 10 Ulverdale Road, King's Road, Chelsea, London, S.W.
1867. Kirkby, James W., Pirnie Colliery, Leven, Fifeshire.
1867. Woodward, Henry, F.G.S., British Museum, London.
1867. M'Chesney, Joseph H., Professor of Geology, University of Chicago, U.S.
1871. Hull, Edward, M.A., F.G.S., &c., Director of the Geological Survey of Ireland, Dublin.

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1872. Thomson, Sir William, LL.D., F.R.S., &c., Professor of Natural Philosophy, University of Glasgow, *President.*
1872. Young, John, M.D., F.G.S., &c., Professor of Natural History, University of Glasgow.
1872. De Koninck, M. L., Professor of Natural History, Liége.
1864. Hunter, John R.S., LL.D., &c., Daleville, Braidwood, Carluke. [1879]*
1883. Judd, Prof., F.G.S., Geological Soc., Burlington House, London, W.
1883. Brown, Robert, F.G.S., &c., Ferslev, Rydal Road, Streatham, London, S.W.

## Honorary Associates.

1859. Struthers, Thomas, Gourock. [1867]
1867. Croll, James, LL.D., &c., Geological Survey of Scotland, Edinburgh.
1858. Crosskey, Rev. H. W., LL.D., F.G.S., Birmingham. [1871]
1858. Horne, James, London. [1871]
1859. Farie, James, Canonbury, London. [1871]
1878. Lapworth, Charles, LL.D., F.G.S., &c., Sir Josiah Mason College of Science, Birmingham.
1858. Wünsch, E. A., F.G.S. [1881]
1883. Traquair, R. H., M.D., F.R.S., F.G.S., &c., Museum of Science and Art, Edinburgh.
1873. Geikie, James, LL.D., F.R.S.E., F.G.S., Professor of Geology and Mineralogy, University of Edinburgh. [1883]

## Corresponding Members.

1859. Dougall, John, M.D., 115 Paisley Road, Glasgow.
1860. Sommerville, George, Thornliebank.
1862. Hunter, James, Ironmaster, Coltness.
1864. Grierson, T. B., M.D., Thornhill, Dumfriesshire.
1864. Mitchell, Rev. Hugh, Craig, Montrose.
1865. Winchell, Alex., Professor of Geology, University of Michigan, U.S.
1866. Gloag, Rev. Dr. Paton J., Manse, Galashiels.
1866. Myers, Rev. Edward, F.G.S., 20 Summerhill Terrace, Birmingham.
1867. Craig, Robert, Langside, Beith.
1867. Gordon, Rev. Dr., Manse of Birnie, Elgin.
1867. Kerr, David, Wemyss Colliery, Fifeshire.
1867. Linn, James, Geological Survey of Scotland, Edinburgh.
1871. Jack, R. L., Australia.
1871. Jamieson, T. F., F.G.S., Ellon, Aberdeenshire.
1871. Kinahan, G. H., Geological Survey of Ireland, Dublin.
1871. Molyneux, William, F.G.S., Burton-on-Trent.
1871. Ward, John, Longtown, Staffordshire.
1876. Dobbie, J. J., M.A., B.Sc., Professor of Chemistry and Geology in the University College of North Wales. [1884]

* The date within brackets [ ] after a name shows when a member was placed on the Honorary or Corresponding list.

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1878. Stewart, Rev. Alex., F.S.A., Ballachulish Manse, Nether-Lochaber.
1880. Patton, Andrew, East Kilbride.
1880. Scott, Thomas, 7 Caddlehill Street, Greenock. [1883]
1883. Lindström, Professor G., Norway.
1883. Bedford, Rear-Admiral, Paignton, Torquay.
1883. Smith, W. Anderson, Ledaig.
1884. Nathorst, Dr. Alfred Gabriel, Geological Survey Office, Stockholm, Sweden.

## Resident Members.

**The names with a star [*] are Life Members. The date within brackets [ ] is that of election as a Life Member.**

1865. Alexander, George R., 42 Sardinia Terrace, Hillhead.
1884. Alexander, J. J., 43 West Regent Street, Glasgow.
1868. Allan, Archibald B., C.E., 4 Victoria Drive, Mount Florida.
1882. Anderson, James, 76 Howard Street, Glasgow.
1881. Armour, P. W., Jane Villa, Pollokshields.
1881. Armour, Wm. C.E., 207 West George Street, Glasgow.

1875.*Bain, Sir James, 3 Park Terrace, Glasgow.
1867. Bannerman, David, 9 Waterloo Street, Glasgow.
1858.*Barr, Thomas M., C.E., Caledonian Railway, Perth. [1881]
1872. Baxter, William, 16 Gibson Street, Hillhead, Glasgow.
1874.*Belch, John, 142 Main Street, Anderston, Glasgow.
1858. Bell, Dugald, 27 Lansdowne Crescent, Glasgow.
1859. Bennie, James, Geological Survey of Scotland, Edinburgh.
1877. Blair, Matthew, 104 Causeyside, Paisley.
1884. Bone, Charles C., C.E., 23 Miller Street, Glasgow.
1882. Brand, John, 81 Gloucester Street, Glasgow.
1883. Brown, George S., 368 New City Road, Glasgow.
1877. Buchanan, John, 230 Duke Street, Glasgow.
1866. Burnet, John, 167 St. Vincent Street, Glasgow.
1876. Burns, Walter, 42 Virginia Street, Glasgow.

1873. Cameron, Robert, 123 St. Vincent Street, Glasgow.
1877. Campbell, John M., City Industrial Museum, Kelvingrove Park, Glasgow.
1880. Carmichael, Robert S., Audit Office, St. Enoch Station, Glasgow.
1865. Carrick, John, 74 Hutcheson Street, Glasgow.
1875.*Clavering, Thomas, 21 St. Vincent Street, Glasgow.
1883. Clelland, John, B.Sc., C.E., Woodhead Cottage, Old Monkland.
1875.*Collins, Sir William, 3 Park Terrace, East, Glasgow.
1884. Connochie, William, Plains, by Airdrie.
1866. Connal, Michael, Virginia Buildings, Glasgow.
1878. Connell, Thos. A., 58 West Regent Street, Glasgow.
1875. Coutts, James, 44 Dorset Street, Glasgow.
1874. Cox, C. C., St. Matthew's College, Walsall.

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1861.*Dairon, James, F.G.S., 4 Garden Street, Glasgow. [1874]
1877.*Dansken, John, 121 West Regent Street, Glasgow.
1874. Darling, George E., 178 St. Vincent Street, Glasgow.
1884. Davidson, Thomas, 41 St. Enoch Square, Glasgow.
1881. Dickson, John, 196 Parliamentary Road, Glasgow.
1877. Dick-Cleland, A. B., Kilrock, Bridge of Allan.
1876. Dixon, E. M., 11 Hopetoun Place, Glasgow.
1883.*Dobbie, Charles Lizars, 21 Hamilton Park Terrace, Glasgow.
1885. Douglas, Loudon M., 20 Canal Bank, Glasgow.
1881. Doddrell, E. E., 7 King Street, S.S., Glasgow.
1881.*Dougan, John, 1 Wilson Street, Hillhead, Glasgow.
1867. Drew, Alexander, 149 West George Street, Glasgow.
1875.*Dron, John, 8 Broomhill Drive, Partick.
1875. Dunlop, E. D., 68 St. Vincent Street, Glasgow.
1883. Dunlop, Robert, 14 South Bridge Street, Airdrie.
1879. Dunn, Peter, C.E., Endrick Villa, Pollokshields.
1868. Dunn, William, 183 West George Street, Glasgow.

1884. Edmiston, James, 297 Argyle Street, Glasgow.

1872.*Farquhar, Bailie, 13 Belhaven Terrace, Hillhead, Glasgow.
1883. Farquhar, John, Jun., 80 York Street, Glasgow.
1867. Fergus, Andrew, M.D., 191 Bath Street, Glasgow.
1883. Ferguson, William, 36 Hill Street, Garnethill, Glasgow.
1870. Fletcher, Thomas, 37 Bath Street, Glasgow.
1872. Forsyth, David, M.A., B.Sc., 49 Carnarvon Street, Glasgow, *Vice-President.*
1884. Fowler, John, Kelvinbank Terrace, Sandyford.
1885. Fullarton, J. H., M.A., B.Sc., Natural History Rooms, University of Glasgow.

1866. Gale, James M., C.E., Corporation Water Works, Glasgow.
1884. Gill, Robert, 117 West George Street, Glasgow.
1873.*Gilmour, Thomas, M.D., Cecil Place, Paisley Road, Glasgow. [1878]
1866.*Glen, David Corse, C.E., F.G.S., 14 Annfield Place, Glasgow, *Vice-President.* [1881]
1859. Gossman, Adam, 79 Robertson Street, Glasgow.
1879. Graham, Alex. M., 21 Bath Street, Glasgow.
1877. Graham, M. M., 21 Bath Street, Glasgow.
1866. Grant, James, 8 Queen's Terrace, Glasgow.
1881. Gray, Harry, 15 Newton Terrace, Glasgow.
1874. Gray, James, 28 Renfield Street, Glasgow.
1872. Hamilton, Archibald, C.E., Clyde Navigation Office, Robertson Street, Glasgow.
1880. Harvie, John, Clydesdale Bank, Glasgow.
1880. Henderson, James, M.A., 3 Armadale Street, Dennistoun.
1876. Henderson, John, 1 Livingstone Terrace, Paisley Road, Glasgow.
1877. Hill, Thomas N., 209 St. Vincent Street, Glasgow.



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1870. Horne, R. R., Mount Vernon Colliery, Tollcross.
1884. Howat, John, 363 New City Road, Glasgow.
1866. Hunt, Edmund, C.E., 87 St. Vincent Street, Glasgow.
1867. Hunter, Matthew, 70 Union Street, Glasgow.
1859. Hutchison, Alexander, Violet Bank, Langside.
1877. Hislop, George R., F.C.S., F.R.S.S.E., Corporation Gas Works, Paisley.

1884. Jolly, William, F.R.S.E., F.G.S., 25 St. Andrew's Drive, Pollokshields.

1870. Ker, William, 27 West George Street, Glasgow.
1877. Kerr, Charles James, Greenfaulds House, Cumbernauld.
1877. Kincaid, Thomas, 9 Lansdowne Crescent, Glasgow.
1882. King, Hugh B., Kilwinning, Ayrshire.
1882. King, Robert C., Kilwinning, Ayrshire.
1883. King, Robert, 3 Windsor Street, Glasgow.
1874. King, Thomas, 110 Hill Street, Garnethill, Glasgow.
1860. Kirsop, John, 98 Argyle Street, Glasgow.
1867. Knox, Adam, 10 Clayton Terrace, Dennistoun.
1872. Knox, John, 41 Mid Wharf, Port-Dundas, Glasgow.

1883. Laird, Andrew, C.E., 1 Corunna Street, Glasgow.
1874.*Lamb, Thomas, 190 Parliamentary Road, Glasgow.
1880. Lawrie, James, M.D., 6 West Garden Street, Burnbank, Glasgow.
1880. Leggat, Rev. Wm., 153 Greenhead Street, Glasgow.
1873. Long, John Jex, 12 Whitevale Street, Glasgow.
1880. Lucas William, 133 West George Street, Glasgow.

1871. M'Ara, Alexander, 67 Morrison Street, Glasgow.
1873. Macbeth, Daniel, Ashburn, Ascog., Rothesay.
1866. M'Clelland, Andrew S., 115 St. Vincent Street, Glasgow.
1884. M'Donald, A. B., C.E., 74 Hutcheson Street, Glasgow.
1875. M'Gilchrist, John, 113 Hydepark Street, Glasgow.
1867. M'Glashan, John, 114 Candleriggs, Glasgow.
1880. M'Kechnie, Neil, 31 Bank Street, Hillhead.
1882. Mackintosh, Rev. John, The Manse, Uddingston.
1883. MacIntyre, A. C., 99 Renfield Street, Glasgow.
1881.*Maclay, David J., 3 Woodlands Terrace, Glasgow.
1877. M'Lay, William, 11 May Terrace, Mount Florida.
1882. M'Lennan, James S., Oswald Public School, Knightswood, Maryhill.
1878. M'Millan, Daniel, 26 Ashton Terrace, Hillhead.
1876. M'Nee, Forrest, 23 Monteith Row, Glasgow.
1883. M'Phee, Donald, Central Police Court, Glasgow.
1885. Macrone, William, 28 St. Enoch Square, Glasgow.
1883. Macwhirr, John, 201 Dumbarton Road, Glasgow.

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1874. Marshall, Robert, 97 Wellington Street, Glasgow.
1871. Mason Robert, 6 Albion Crescent, Dowanhill, Glasgow.
1867. Millar, John (J. Black, Drew & Co.), 23 Royal Exchange Square, Glasgow.
1876. Miller, Arch., Shawlands Academy, Crossmyloof.
1866. Miller, James, 17 Monteith Row, Glasgow.
1881. Mitchell, G. A., 67 West Nile Street, Glasgow.
1877. Moore, Robert T., C.E, B.Sc., 134 St. Vincent Street, Glasgow.
1871. Morrison, William, Jun., 267 Argyle Street, Glasgow.
1865. Mossman, John, 6 Queen's Terrace, West, Glasgow.
1885. Muir, William, 3 North Street, Anderston, Glasgow.
1877.*Muirhead, Henry, M.D., Bushy Hill, Cambuslang.
1874. Munro, John, 87 Wellington Street, Glasgow.
1859. Murdoch, James B., F.R.Ph.S.E., Barclay, Langside, Glasgow, *Honorary Secretary.*
1875. Murdoch, William, 20 Carlton Place, Glasgow.
1870.*Murray, David, 13 Fitzroy Place, Glasgow.

1861. Naismith, Thomas, 233 Duke Street, Glasgow.
1865. Napier, J. W., Woodielea, 14 Windsor Circus, Glasgow.
1868. Neilson, Richard, 110 John Street, Glasgow.
1867. Norman, John, Keppochhill Engine Works, Glasgow.

1869. Orr, John, 8 Newhall Terrace, Glasgow.

1875. Pearson, D., 15 Carnarvon Street, Glasgow.
1869. Pratt, David, 72 Waterloo Street, Glasgow.
1877. Pratt, Gavin M., 104 West Graham Street, Glasgow, *Assistant Hon. Secretary.*
1884. Petrie, William, 17 Steven Street, Glasgow.
1884. Prentice, James, Stanrigg Collieries, Airdrie.

1873. Rankine, David, C.E., 75 West Nile Street, Glasgow.
1875.*Raphael, Robert, 5 Brookland Avenue, Uddingston.
1880. Reid, James A. (of M'Grigor, Donald & Co.), 172 St. Vincent Street, Glasgow.
1881. Reid, John, 74 Bath Street, Glasgow.
1866. Reid, J. G., 2 Sandyford Place, Glasgow.
1877. Renison, William, 3 Woodside Place, Glasgow.
1874. Renwick, John, Blacklands, Maryhill.
1877. Rhind, John, 82 Hill Street, Garnethill, Glasgow.
1880. Riddell, David, 10 and 12 Graham Square, Glasgow.
1867. Robertson, Archibald, 25 Queen Street, Glasgow.
1867. Robertson, David, F.L.S., F.G.S., Glendale, Uddingston.
1872. Robertson, David, 205 Hope Street, Glasgow.
1868. Robertson, Joseph, 110 John Street, Glasgow.
1866. Robertson, John, 10 Valeview Terrace, Mount Florida.
1878. Ross, David, M.A., B.Sc., 47 Carnarvon Street, Glasgow.

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1875.*Rottenburg, Paul, Holmhurst, Dowanhill Gardens.
1865. Rowan, David, 22 Woodside Place, Glasgow.

1861.*Sandeman, David, 11 John Street, Glasgow.
1884. Simmons, Wm., 70 Fort Street, East Pollokshields.
1871.*Smellie, Thos. D., 213 St. Vincent Street, Glasgow.
1877. Smith, Hugh, 25 Regent Park Terrace, Strathbungo.
1865. Smith, John, Eglinton Ironworks, Kilwinning.
1871. Sommerville, Joseph, 76 Henderson Street, Glasgow.
1881. Steel, James, 5 Rosehall Street, Glasgow.
1884. Steele, Robert, 100 Kenmure Street, Pollokshields.
1880. Stewart, James, of Williamwood, Cathcart.
1878. Stewart, James F., Kippen, Stirling.
1878. Stewart Thomas, Hydraulic Engineers' Department, Cape Town.
1867. Stewart, Thomas P., 55 Anderston Quay, Glasgow.

1866. Taylor, Wm., 144 Wellington Street, Glasgow.
1875. Telfer, David, 2 Clifton Street, Glasgow.
1858. Thomson, James, F.G.S., 3 Abbotsford Place, Glasgow.
1878. Thomson, John, Govan Park, Govan.
1883. Townsend, Alexander Watson, 128 Bishop Street, Port-Dundas, Glasgow.
1883. Townsend, Robert, 128 Bishop Street, Port-Dundas, Glasgow.
1881. Turner, Robert, H.M. Customs, 3 West Bank Place, Hillhead.

1876. Waghorn, George A., 6 Hope Street, Glasgow.
1884. Walker, George W., 10 Airlie Terrace, Pollokshields.
1885. Westwood, Edward, 137 Ingram Street, Glasgow.
1864. Whitelaw, Alexander, 87 Sydney Street, Glasgow.
1880. Whitelaw, Thomas, Coalmaster, Motherwell.
1874. White, James, 56 Rose St., Garnethill, Glasgow, *Hon. Librarian.*
1874. White, James, Free Normal School, Glasgow.
1877. White, J. C., Oakfield Cottage, University Avenue, Hillhead.
1874. Whyte, John, 150 Holland Street, Glasgow.
1866. Wight, John, C.A., 150 Hope Street, Glasgow, *Hon. Treasurer.*
1879. Wight, Robert John, C.E., 7 Berlin Place, Pollokshields.
1860. Wilson, Daniel, 85 Wellington Street, Glasgow.
1881. Wilson, George, 119 Montrose Street, Glasgow.
1874. Wilson, John, 4 Washington Street, Glasgow.
1881. Wotherspoon, David, 130 Dumbarton Road, Glasgow.
1885. Wilson, Hugh, 35 Raeberry Street, Glasgow.

1880. Young, Andrew, 30 Carriage Hill, Livingstone Buildings, Paisley.
1884. Young, Archibald A., 13 Parkgrove Terrace, Glasgow.
1859.*Young, John, F.G.S., Hunterian Museum, University, Glasgow.

[1869]

1875.*Yuille, Thos. Smith, 119 Trongate, Glasgow.

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THE

# GEOLOGICAL SOCIETY OF GLASGOW.

INSTITUTED 1858.

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## CONSTITUTION AND LAWS,

*AS AMENDED, SESSION 1874-75.*

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### I.—NAME.

The Society shall be called "THE GEOLOGICAL SOCIETY OF GLASGOW."

### II.—OBJECTS.

The objects of the Society shall be—

I. To unite, in permanent working association, the students and friends of Geological Science residing in Glasgow and surrounding districts.

II. The advancement of that Science, by means of periodical Meetings for its study; the reading and discussion of original Papers on subjects illustrative of Geology or its allied Sciences; the exhibition and description of Specimens; the delivery of Lectures during winter; and by Excursions in summer.

III. The formation of a Library and Museum, specially to illustrate the Geology and Palæontology of the district.

IV. The publication of the Society's *Transactions*.

### III.—CONSTITUTION.

The Society shall consist of—I. Ordinary and Life Members II. Honorary Members; III. Honorary Associates; IV. Corresponding Members.

### IV.—ORDINARY AND LIFE MEMBERS.

All candidates for Membership shall be proposed on the recommendation of two Members, at one Meeting, and their election

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put to the vote from the Chair at the following Meeting, whether Ordinary or Special, provided their names shall be announced in the Circular calling the Meeting at which they are to be brought forward for election. If not unanimous, the vote shall be taken by ballot, and a majority shall suffice for election.

The Annual Subscription shall be—for Gentlemen, 10s., and for Ladies, 7s. 6d., payable upon election, and thereafter at the first Ordinary Meeting of each Session in October.

Members whose Subscriptions are in arrear shall not be entitled to vote, nor to use the Library, nor to receive the printed *Transactions* of the Society.

Members shall be held liable for their Annual Subscriptions until they have given the Secretary written notice of their resignation.

A single payment of Five Guineas shall entitle any Member elected as aforesaid to be entered as a Life Member of the Society.

## V.—HONORARY MEMBERS, HONORARY ASSOCIATES, AND CORRESPONDING MEMBERS.

The Ordinary Members shall have power to elect—on the motion of two of their number—Honorary Members, Honorary Associates, and Corresponding Members, at any Meeting, provided notice of said motion has been tabled at a previous Meeting and received the sanction of a majority of the whole Council. The votes of two-thirds of the Members present shall be requisite for the election of all such Members.

(1.) Persons distinguished for their attainments in Geology or the allied Sciences shall be eligible as *Honorary Members.* These shall be entitled to the same privileges as Ordinary and Life Members.

(2.) Persons resident in Glasgow or neighbourhood who may have benefited the Society by services rendered, by donations of books or specimens, or by the contribution of original communications, shall be eligible as *Honorary Associates.*

(3.) Friends and Students of Geological Science, resident at a distance, who may be willing to forward information or communications to the Society, shall be eligible as *Corresponding Members.*

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Honorary Associates and Corresponding Members shall be entitled to attend the Meetings, Lectures, and Excursions of the Society, but shall have no vote in the management of its affairs, nor be entitled to receive copies of the *Transactions*, except at the discretion of the Council.

## VI.—OFFICE-BEARERS.

The business of the Society shall be conducted by a Council of twenty, consisting of a President, three Vice-Presidents, a Corresponding Secretary, a Joint Secretary, a Treasurer, and a Librarian (who shall also be Curator of the Museum), and twelve Councillors, to be elected as hereinafter prescribed.

*Mode of Election.*

The election of Office-bearers shall take place by ballot, at the Annual General Meeting of the Society. The names of those intended to be proposed as Office-Bearers, together with their proposers and seconders, shall be sent in to the Secretary at least eight days before the Annual General Meeting, and submitted to a meeting of Council, and intimated in the Circular calling the Annual General Meeting.

*Term of Office, &c.*

The President shall be elected for three years, and shall be eligible for re-election. He shall be Chairman of the Council, and of all Meetings at which he may be present. In his absence, one of the Vice-Presidents, or, failing them, a Member of the Council shall preside.

One of the Vice-Presidents and four of the Council shall retire annually by rotation, to be arranged in the first instance after these rules are passed, by those having the lowest number of votes at election retiring from office at the end of the first year, and the next lowest at the end of the second year; after which they shall retire in regular rotation by seniority of office.

In the event of an equality of votes, a second ballot shall be taken.

The retiring Vice-President and Members of Council shall not be eligible for re-election to the offices from which they retire until they have been one year out of said offices.

The Secretaries, Treasurer, and Librarian shall be eligible for re-election.

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## VII.—SECRETARIES.

The Corresponding Secretary shall conduct the correspondence, and record in the Minute-Book the proceedings of all Meetings of the Society, the Council, and Sub-Committees, of which he shall be *ex-officio* a Member.

The Minutes of all such Meetings respectively shall be read and confirmed as the first business of the next ensuing Meeting.

The Corresponding Secretary shall also edit the *Transactions* of the Society, and superintend the publication of same as often as may be approved of by the Council. A *Publishing Committee*, consisting of two or three Members, to be elected annually by the Council, shall be associated with the Secretary for this purpose, as also to assist in preparing Abstracts of Papers, Reports of Excursions, &c.

The Joint Secretary shall take the charge of calling all Meetings of the Society or Council, and sending out all Circulars to the Members regarding Lectures, Excursions, &c. For this purpose he shall keep a Register of the names of Members of the Society, for reference.

He shall also take the place of the Corresponding Secretary at all Meetings when the latter may be absent.

## VIII.—TREASURER.

The Treasurer shall receive and pay (as authorised by the Council, or by any General or Special Meeting of the Members) all monies connected with the Society, and shall keep a regular account of the same, which account shall be balanced as on the 30th of September of each year, audited by two Members other than Members of Council, appointed at an Ordinary Meeting, and submitted to the Annual Meeting in October.

## IX.—LIBRARIAN AND CURATOR.

The Librarian shall have charge of the Society's Library, and shall arrange and keep a Catalogue thereof. He shall also have charge of the Museum, and of all Property belonging to the Society.

The *Transactions* shall be exchanged with such Societies and Geological Authors at home and abroad as may be approved of

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by the Council. The Librarian shall have charge of such exchanges, and shall keep a correct list thereof, for purposes of reference.

## X.—COUNCIL.

The Council shall meet as often as may be requisite for the transaction of business—five shall form a quorum. They may appoint Sub-Committees for the management of special business, and shall issue yearly, prior to the Annual Meeting, a Syllabus of their arrangements for the Winter Session; and before its close, one of their arrangements for the Summer Excursions.

Any vacancy occurring in the Council during the year may be filled up by the Council; but such elections to fill vacancies shall only be for the unexpired portion of the previous occupants' term of office. Members so elected, however, shall be eligible for re-election if their period of office has not extended to two years.

## XI.—MEETINGS.

Ordinary Meetings of the Society shall be held once a month during the Session, on the first or second Thursday evening of each month, at eight o'clock; but more frequently if the Council should deem it advisable. At these Meetings, after the Minutes of the previous Meeting have been read and confirmed, the vote shall be taken on Members who have been proposed; other new Members may then be proposed; Papers read and discussed; Specimens exhibited and remarked upon, and any other business disposed of.

The Session shall last from October to April. The first Meeting of each Session shall be an Ordinary Meeting. The second Meeting, at such interval from the first as may be fixed upon, shall be the

*Annual General Meeting,*

At which one of the Secretaries shall give a Report of the proceedings of the Society during the past year; the Treasurer shall submit a Statement of the Cash Account, audited by the two Members appointed for that purpose; and the Librarian and Curator shall report on the progress and condition of the Library and Museum. The election of Office-Bearers shall then be proceeded with.

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*Special Meetings.*

The Council or Secretary shall be empowered to call, at any time when necessary, a Special Meeting of the Society, and shall be bound to do so on the written requisition of ten Members, specifying the business to be submitted thereto.

At all Meetings, the resolutions of a majority of those present —with the exceptions stated in Laws V. and XV.—shall be binding. The Chairman shall have both a deliberative and a casting vote.

All Meetings shall be intimated to the Ordinary and Life-Members by Circular.

## XII.—LIBRARY AND MUSEUM.

The Members shall have access to the Library and Museum on the nights of meeting, and at such other times as the Council may direct.

The Rules approved of by the Council for the conduct of the Library shall be printed along with the Catalogue.

## XIII.—VESTING OF PROPERTY.

The property of the Society shall belong solely to the Ordinary and Life Members, and shall be vested for their behoof in the Council for the time being. The Council shall have the management of the property, and power to sell or otherwise dispose of any duplicate Books or Specimens; any other property which they may consider unnecessary to retain shall only be disposed of with the consent of a majority of the Ordinary and Life Members present at a Meeting of the Society. Notice shall be given in the Circular calling the Meeting, of the intention to ask such consent.

## XIV.—APPLICATION OF FUNDS.

The Annual Subscriptions shall be chiefly devoted to the Publication of the Society's *Transactions*, of which each Member shall be entitled to receive a copy, beginning with the part relating to the Session in which he has been elected.

Should the Subscriptions at any time be insufficient for this purpose, the Council shall have power to fix such a charge for

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each Part of the *Transactions* as may be required to make up the deficiency.

Duplicates and back parts shall in all cases be charged for at full publishing price.

Authors of Papers printed in the *Transactions* shall be entitled to receive thirty copies of their papers free.

Sums may be voted from time to time by the Council to the Library and Museum, out of any funds there may be on hand. No purchase of Books or Specimens exceeding Two Pounds in value shall be made without the sanction of a General Meeting of the Society.

The Subscriptions of Life-Members shall be retained as a separate Fund for the re-publication of such *Memoirs* or Parts of the *Transactions* as may be out of print, and be still in demand; for the expense of special Publications or of Exhibitions in connection with the visits of learned Societies; and generally for such exceptional purposes as are not provided for by the Annual Subscriptions.

The Council shall obtain the sanction of the Society at a General Meeting before applying any portion of this Fund.

## XV.—ALTERATION OF CONSTITUTION OR LAWS.

No alteration shall be made in the Constitution or Laws of the Society except at a General Meeting specially intimated for that purpose. Notice of any proposed alteration shall be tabled at the Ordinary Meeting preceding, and shall not be adopted unless agreed to by two-thirds of the Members present.

## XVI.

Any Contingency not provided for in these Rules shall be submitted to the Council, and their decision shall be final and binding on all concerned.

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